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J. W. D. Gibson

THE BUILDER'S GUIDE,

AND

Estimator's Price Book.

BEING A COMPILATION OF

CURRENT PRICES OF LUMBER, HARDWARE, GLASS, PLUMBERS' SUPPLIES, PAINTS, SLATES, STONES, LIMES, CEMENTS, BRICKS, TIN, AND OTHER BUILDING MATERIALS; ALSO, PRICES OF LABOR, AND COST OF PERFORMING THE SEVERAL KINDS OF WORK REQUIRED IN BUILDING.

Together with prices of Doors, Frames, Sashes, Stairs, Mouldings, Newels, and other Machine Work. To which is appended a large number of Building Rules, Data, Tables and Useful Memoranda, with a Glossary of Architectural and Building Terms.

BY

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NEW YORK:
THE INDUSTRIAL PUBLICATION COMPANY.
1882.

PREFACE.

This work is chiefly intended to assist the Builder and Contractor, in making estimates of the cost of work they may be competing for. A great deal of information often required by contractors cannot be obtained without trouble and serious loss of time, consequently their estimates are frequently guessed at, and their tenders for construction are either absurdly too high, or ridiculously low.

This little book is intended in a measure to remedy this defect in estimating, by bringing before the estimator the details to be estimated as far as possible, and their approximate cost. It is impossible, however, to quote prices that will suit every locality or all time, but we have provided for this by leaving a blank column where prices may be entered in pencil, to suit locality and time.

The prices given in this book are only intended to form a basis upon which the contractor can place a percentage; they are approximately correct, but in all cases we advise a comparison with the prices current.

Besides the hints and aids to the estimator, we have embodied in the book a number of valuable tables and memoranda of a useful and scientific kind. These are taken from standard works by Nicholson, Barlowe, Tredgold, Rankine, Fairbairn, Hodgkinson, Trautwine, and others, as well as a large amount of building information, rules, and recipes, that must prove of value to all interested in the construction, repairs, or decoration of buildings.

We have also included a glossary of terms used in architecture and building.

Although many things in this work have never appeared in book form before, we make no claim to originality beyond that of bringing before the builders, contractors, and artisans of America, in a condensed form, a greater amount of practical information than is to be found in any similar work.

Real estate owners and insurance valuators, we think, will find this little work of great service in their every-day transactions.

HINTS AND AIDS

IN ESTIMATING.

The rules known to architects, builders, and contractors, for obtaining an approximate estimate of buildings by cubing the quantities, are of little service to beginners, unless they possess an intimate knowledge of the different classes of buildings and their values, and can make the proper allowances for extra charges to be added for costly material and enrichment, all of which have to be taken into account. It is always the safer way to take trouble and time in fully preparing a statement in brief of details, both of work and material, when making an estimate, then omissions will likely be noticed and adjusted.

It must always be borne in mind that it is not the mere wall, rough carpentry, plastering and roofing that makes the great bulk of the cost of a building, unless one of a very plain description. It is the decorative part and interior finish and numerous small, but expensive items, that swell the bill.

In the first place, there should be a design of the building, elevations, plans and details; and no proprietor, builder, or contractor should begin work until these are supplied; for building without a plan is like sailing a ship without a rudder, and is sure to end in trouble and disappointment, both to contractor and owner. After a plan is agreed upon, and

the contract signed, no deviation should be made, as very often what may appear a trifling matter to the owner, may involve so many changes in other parts of the building, as to be more costly than serviceable.

After the quantities are taken out, and written down in the form herein given, and the prices current for material and labor in each particular added; the prices being for the completed work, as, for instance, the price of a door should mean the cost of the door, frame, casings, architraves, lock, hinges, mouldings, fixing and hanging complete, including the painting. By adopting this system the estimator will know that each item is complete, and it will almost be impossible to err in the final result. When all the items are written up, and everything is known to be entered, the totals should be made up, and 20 per cent. added to cover contingencies.

It is a convenient practice to those unaccustomed to taking out quantities, to note down on the plan of each room the quantity of plastering, cornice, flooring, wainscoating, windows, doors, blinds, etc., contained therein, and abstract afterwards the different items under their proper headings.

The following is a good form for an estimate. Use foolscap paper, and rule same as this:

Quantities.	Description of Work.	Price. $ cts.
300	Yards, cubic, excavating for foundation walls, drains, posts, etc., etc., and removing stuff...	
40	Toises rubble masonry in foundation walls, including all materials set in mortar, pointed, including moving rubbish..................	
84	Thousand bricks laid in mortar, in walls and partitions, joints struck, including setting of all walls, plates, boards and other timber....	
3000	Feet, lineal, of flooring joists, 10 x 3, fixed complete, with all trimming pieces, etc......	

Quantities.	Description of Work.	Price. $	cts.
16	Squares of 1½ inch matched flooring, laid complete, including nails.....		
18	Doors, 3 x 7 feet, 2 in. thick, in four panels, moulded on both sides with 7½ inch moulded architraves, casings, frame and threshold complete, including 3-inch butts and lock worth not less than 80 cts.; hung and trimmed complete..................................		
12	Windows and frames, sashes 6 ft. x 3 ft., 4 in., in four lights. Frames to be prepared for weights, sashes to be double hung and furnished with proper window locks. Glass to be ——— brand and well glazed...........		
12	Pairs of inside shutters or blinds, to open in two flaps on each side, moulded soffit, sills, etc., hung complete........................		
10	Double windows, etc........................		
12	Summer blinds, etc.........................		
80	Yards of stucco cornice.......		
1006	Yards of plastering, three coats, hard finish, including lathing and all materials..........		
7	Centre pieces..............................		
2	Stucco brackets in hall		
2	Flights of stairs, including rails, newels, balusters, brackets. and all complete..............		
20	Squares of slating, including all materials....		

The foregoing description will be a guide for all other items. After making use of these forms, they should be carefully laid aside for future reference.

General Memoranda of Items for Estimates.

Excavations, per cubic yard; ascertain the quantity of earth to be excavated for foundation walls, drains, fence posts, etc.

Foundation Walls, per cubic foot, 87 ft. English, to the toise of masonry. Find the number of cubic feet in walls and footing courses, deducting all openings over 9 feet in width.

Tile Drains. Calculate the number of lengths, bends and junctions required, add cost of laying and connecting, including covering in, etc.

Galvanized Iron and Lead Pipes. State the length and diameters of all galvanized iron pipes necessary, and the weight of lead pipes per yard lineal, together with all traps, overflow pipes, and cocks necessary.

Water Closets. If water closets are to be provided, state how to be fitted up, and cost.

Bath. State description of bath, if of galvanized iron or other metal, including fixing in frame and casing.

Brick Walls per foot cube. 20 bricks (of 8 ins. x 2½) are generally allowed to a cubic foot. Find the number of cubic feet in the walls, division walls and chimneys, deduct all openings. Measure all chimneys as solid.

Carpentry.—Under this head commence with the heavy timbers, such as flooring joists, roofing, wall plates, lintels, bond timber, wood-bricks, insertions for cornices, projections for galleries, studding for partitions, furring for ceilings, skirting, trimmers, etc. Framing for stables, fencing and posts.

Joiner's Work. This will include all floors, doors, windows, blinds, shutters, casings, base, and fittings of every description in wood work, all the different sized doors and windows must be kept separate.

Stove Pipe Rings. State number.

Mantel Pieces and Grates. Number mantel pieces and grates, and state price, provide for hearth stones and fixings all complete.

Closets. State quantity of shelving required, cloak nails, hooks, etc., omit not to calculate for plastering and skirtings.

Pantry. Describe the fitting up of pantry whether with cupboards or open shelves and state if with sinks, and cost.

Kitchen. State how to be fitted up with shelves, pantry, closets, etc.

Bell Hanging. State number of bells, fixed complete.

Gas Pipes. State number of lights in each room, etc.

Staircases. Describe the different stairs and their length, width and thickness; state the kind of balusters and their number, also newels, give the dimensions of hand rail.

Roof. Describe the kind of roof, whether metal, and what kind. If slate, number of piles of felt under it, gravel—do.

Gutters and Conductors. State the width of gutters and how to be lined, and also length and direction of gutters.

Outside Porches. Provide for all double doors, and construction of porches as described in specifications, as well as all steps leading thereto.

Fences. State the different kinds of fences and take a price at per lineal foot, including gates and everything necessary to complete them.

Of course there will be many other items than these described in a specification, but sufficient has been stated to enable the builder to calculate as to the value of the building he contemplates erecting, before giving in a tender for the work.

If the building is to be all of timber, a balloon frame, the following hints as to material and labor will be found very useful. The cost of a building can closely be calculated, when the price of material and wages per day are known.

Mark on the plan figures showing dimensions and measurements of every thing in the building on which you are to estimate.

Get the linear measurement of all the sills, and from their size estimate the number of feet, board measure. Retain the linear measurement, as from that the labor amount is estimated. The labor on sills is confined to three kinds. 1st.

Framing without gains for joists or mortises, for studding as in common building when the studding is spiked to the sills and the joists rest on their top. 2d. With mortises for studding, gains for joists, or studding without mortises. 3d. With both mortises and gains.

Sills, 6 x 8, framed and placed in the building by the 1st, 2d and 3d processes, will cost for labor about 2, 4 and 6 cents per lineal foot. Sills, 12 x 16, double above prices. The intermediate sizes can be approximated from the above figures.

Joists are ordinarily placed 16 inches from centre to centre, and when so placed the number of joists on a given floor can be found by taking ¾ of the length of the building and adding one joist where they are placed on top of the sill, and deduct one where the end sills are used in place of joist. First floor joists usually are 2 x 8 to 2 x 14. Second floor 2 x 8 to 2 x 12. Ceiling joists, where no floor rests thereon, are 2 x 6 to 2 x 8.

Two men will frame and place in a wood building, not exceeding three stories, 700 lineal feet of joists, in size from 2 x 6 to 2 x 14 stuff, in one day.

In brick buildings not exceeding three stories, including anchoring and leveling up, 500 feet. Fourth story work, 400, and fifth story 300 lineal feet.

The cost per lineal foot can be had from the above figures.

When joists are doubled under chimneys or partitions, the number of joists so used must be added to the result above named.

In balloon frames no braces are used. In timber frames they are made as follows:

1st. Cut off plain, spiked in, or "flat foot."

2nd. With short tenons, and 3d, with long tenons and pinned. Braces vary in size from 4 x 4 to 6 x 6. The cost of labor will not vary on account of difference in size. The first

pieces will cost 1½ cents, the second 3 cents, and the third 4 cents per lineal foot, framed and placed in the building.

The plates in a balloon frame are made of scantling of the same size as the studding, and are worth to get out and spike to the frame 1 cent per lineal foot.

In timber frames the labor on plates is: 1, framing without braces or gains for rafters; 2, framing with braces and no gains for rafters; 3, framing with both braces and gains. An average price for labor on plates in sizes from 4 x 6 to 6 x 10 would be: 1st process, 2 cents; 2d process, 4 cents; 3d process, 6 cents per lineal foot. From 8 x 12 to 12 x 16, respectively 3, 5 and 8 cents per lineal foot. This includes placing them in the building. Plates laid on walls are worth the same as plates spiked on the joists.

Posts in balloon frames are merely double-studding. The cost of placing them in position is the same as for studding.

Posts for timber frames are framed, first, with tenon top and bottom. Second, the same, with one set of braces with girt or beam mortises; and third, the same, with two sets of girt or beam mortises.

By the first process posts from 4 x 6 to 8 x 10 would cost 3½ cents. Second process, 5½, and the third process, 8½ cents per lineal foot to frame and place in the building.

Studding for balloon frames is usually placed 16 inches from centre to centre. They vary in size from 2 x 4 to 2 x 6. Occasionally odd sizes are used, as 2½ x 4, 2 x 5, or 3 x 4. In an ordinary size frame building two men will lay out and raise 800 lineal feet of 2 x 4 studding per day, or 750 feet of 2 x 6.

At $2 per day the first would cost 50 cents per hundred lineal feet. The latter 53⅓ cents. The labor of spiking of joists and plates being considered under their respective heads; the work on studding is simply confined to tenoning and studding on end, or spiking them to the sills.

A short rule for getting the number of pieces of outside studding, including plates, and allowing for doubling at all corners, and for windows and doors, is simply had by allowing one piece of studding for every foot of outside measurement. This rule for buildings having many angles, where studding must be doubled approximates very closely to the true result. In smaller buildings, without any angles, it will somewhat overrun.

The exact number of pieces of studding on the outside of a building may be found by taking three-fourths of the number of feet in the outside measurement of the building; add one stud for each corner and angle, and one for each door and window. To this add for plate and gable studding.

Three-fourths of the number of lineal feet of all partitions will give the number of pieces required. Their length, of course, depends upon the height of the rooms.

The cost of labor is the same as for outside studding.

It frequently happens that the studding is not double for doors and windows, and occasionally the extra stud for the corners is omitted.

Ribs for studding are usually made from 1 to 1½ inch stuff, and will cost to lay out and nail to the studding about three-fourths of a cent per lineal foot. The purpose for these is to support the upper joist.

Three-fourths of the width of the building, less one, gives the number of pieces required for gable; the average length of each piece is the distance from the plate to the ridge of the roof, or what is termed the rise of the rafter.

Rafters are designated as main or principal rafters, hip, jack, and valley rafters, and plain rafters.

The long rafters of a hip roof are called the main or principal rafters.

The shorter ones are called jack rafters.

A plain rafter is the ordinary rafter used in straight gable roofs.

The projection of a rafter is the distance it extends beyond the plate—or the length of the look-outs.

The *rise* of a rafter is the height on a perpendicular line from the plate to the ridge of the roof.

The *gain* of a rafter is the difference between the run and its length.

The run of a rafter is the distance from the outer edge of the plate to a point immediately under the ridge of the roof, or one-half the width of the building.

For a common rafter, to the square of the rise, add the square of the *run*. The square root of their sum is the length of the rafter from the outer edge of the plate to the ridge of the roof.

The *rise* of a rafter is found by multiplying the number of inches rise required by the run by one-half the width of the building.

The *rise* in ¼ pitch is ¼ the width of the building. In a ⅓ pitch, ⅓ the width of the building. In a ½ pitch, ½ the width of the building, etc.

A common rafter can also be found as follows: If the roof is ¼ pitch, to the square of ¼ of the width of the building add the square of ½ the width of the building. The square root of the sum will be the length of rafter required. If a roof is ⅓ pitch square, ⅓ of the width of the building. If ½ pitch square, ½ the width, etc., and then proceed with the balance of the rule.

Required the length of rafters for a building 24 feet wide, gable roof, and ¼ pitch.

One fourth of 24 equals 6—½ of 24 is 12. Squaring both gives 36 and 144, or 180—the square root of which is 13·416 feet, or length of rafter required.

Rule for estimating the length of rafters for hip roofs where they are of equal lengths:

Get the length of the main rafter by using the rule for common rafters. Then divide the length of the main rafter into one more space than the number of rafters required. The length of the space is the length of the shortest jack rafter, and the length of each studding rafter is simply the space added to the length of the preceding one.

Example.—Main rafter 24 feet. No. of jack rafters required, 7. Hence the number of *spaces* would be 7 + 1, or 8. Dividing 24 by 8 gives 3 ft. as the length of the shortest rafter. The next would be 6 ft., then 9 ft., 12 ft., 15 ft., 18 ft., 21 ft., and then comes 24, or the main rafter

Common rafters on shingle roof are placed from 16 to 24 inches from centre to centre, according to the length and weight of roof required; generally two feet is the distance.

The number of rafters in a plain gable roof is found by dividing the length of the building by the distance the rafters are apart from centre to centre, to which add one; the result is the number of *pairs* of rafters.

Cost of framing rafters.—Two men in one day will frame and place in the building 600 lineal feet of 2 x 4 or 2 x 6 rafters—roof, plain gable.

In a hip roof, including framing for deck, if any, 250 feet is a fair day's work.

At $2.10 per day the former would cost 66⅔ cents per lineal 100 feet, and the latter $1.60 per hundred lineal feet.

The contract price for framing one and a half, two, and two and a half story houses, in many of the Western States, averages sixty-five cents per 100 lineal feet of *all* the bill timber.

In all the framing labor thus considered, reference is had

to soft wood only. If hard wood is used a fair addition to the prices would be 30 per cent.

If any of the work is circular segment or octagonal, an addition must also be made varying from two to four times the prices herein charged.

Lookouts for Hip Roofs.—An average length would be 20 inches. These are made of inch stuff and nailed to the rafters. They are worth, to get out, furnish material and place in position, 15 cents each.

The siding to a building is either drop siding, lap siding, dressed barn boards, or rough barn boards.

The number of feet of drop or lap siding is found by multiplying the outside measurement of the building by the height of the posts, to which add for gables; if roof is a gable roof, the product of the width of the building by the height from the plate to the ridge of the roof. This gives the number of surface feet, to which add one-fifth for lapping, and you have the number of feet board measure.

Two men will put on 800 feet in one day of drop siding when the window-casings and corner-boards are placed over the siding. Where joints are made against casings and corner-boards, 400 to 500 feet is a day's work.

Of lap siding 650 feet. This includes putting up staging. At $2 per day the following is the prices per square: Drop siding by the first method, 50 cents; second method, 75 cents to $1. Lap siding, 62 cents.

Two men will put on 2000 feeet of rough barn boards, or 1500 feet of surfaced barn boards in one day, and will put on 2000 feet of dressed battens, or 3000 of rough battens. Hence the price would be: rough barn boards, 20 cents per 100 feet or one square; surface barn boards, 26⅔ cents per 100 feet or one square. Dressed battens, 20 cents per 100 lineal feet. Rough battens, 13 cents per 100 lineal feet.

Roofs. The area of a plain gable roof is had by multiplying the entire length of the rafters by the length of the building, including the projection of the cornice. This gives one side; doubling it gives the total square feet of roof.

Hip Roof. Get the entire outside measurement of the building, including the projections of the cornice. Multiply this by the length of the principal rafter and take one half; the result is the area of the roof.

Hip Roof with Deck. To the outside measurement of the deck, add the outside measurement of the building as above. Multiply this by the length of the principal rafter, and take one half for the area of the roof.

Roof boards for plain gable roofs are worth 30 cents per square to put on the building, and for hip roofs 45 cents per square.

If roof boards are matched stuff for tin or slate roof, charge 70 cents per square for gable and $1 per square for hip roofs.

Shingles. The average width of a shingle is 4 inches. Hence when shingles are laid 4 inches to the weather, each shingle averages 16 square inches; and 900 are required for a square of roofing.

If 4½	inches	to one another,	800	will cover	a square.
" 5	"	"	720	"	"
" 5½	"	"	655	"	"
" 6	"	"	600	"	"

This is for common gable roofs. In hip roofs, where the shingles are cut more or less to fit the roof, add 5 per cent. to above figures.

A carpenter will carry up and lay on the roof from 1500 to 2000 shingles per day, or 2 to 2½ squares of plain gable roofing, so that an average price per square for simply laying the shingles would be 95 cents. Add 30 cents for laying the

roof boards, and the labor account on a common shingle roof would be $1.25 per square.

Tin Roofs. A sheet of roofing-tin is 14 x 20 inches, and a box of tin contains 112 sheets.

Allowing the usual amount for side ribs and top and bottom laps, a box of tin will cover 182 square feet, and is worth about $6 per box. 1 C. charcoal.

Laying a box of tin will cost as follows:

1 box 1 C. charcoal tin, - - - - - -	$6 00
10 lbs. solder, 15c., - - - - - -	1 50
Preparing tin for roof, - - - - - -	1 50
Laying tin, 1 1-5 days at $2.25, - - -	2 70
Total, - - - - - -	$11 70

This makes the actual cost of laying one square of tin $6.43.

Valleys. Tin valleys for shingle roofs are generally 14 inches, and for slate roofs 20 inches wide. An average price put on the roof including material, would be 9 cents per square foot. One man will lay 1½ squares per day of valleys, in plain work; when roof is steep or valleys cut up, 1 square is a day's work.

Flashings. Tin flashings for chimneys and where one part of a building joins another are worth, put on, 10 cents per square foot.

Gutters and Spouts.

Gutters,	4-inch,	are worth,	put up,	10	cents per	lin. foot.
"	5	"	"	12½	"	"
"	6	"	"	15	"	"

Down spouts,	2-inch,	are worth,	put up,	8	cents per	lin. foot.
"	3	"	"	10	"	"
"	4	"	"	12	"	"
"	6	"	"	25	"	"

Slate Roofs. The prices per square for slate roofs can had of slaters in any of our towns and cities.

They will vary from $7 to $10 or $12 per square.

Cornices. An ordinary plain cornice has three members, viz.: frieze, soffit, and facia.

The frieze is the part nailed or fastened to the side of the building.

The soffit is the part attached to the under side of the projection of rafter, or lookout.

The facia is the part attached to the end of the rafters or lookout.

Crown moulding is the moulding on the facia.

Bed moulding is the moulding in the angle where the frieze and soffit join.

In estimating the amount of material in a given cornice for a square roof, multiply the entire outside measurement of the building by the sum of the width of the soffit, frieze, and facia; the result is the number of feet, board measure.

For gable roofs, to the lengths of the two sides of the building add the end projections and length of end rafters and multiply as before.

Table of labor account on cornice work.

Number of feet two men will put on per day and price per foot:

Width in Inches.				
Frieze.	Soffit.	Facia.	No. Feet.	Cost per Foot.
9	10	4	80	5c.
10	12	4	75	$5\frac{1}{2}$
12	16	4	60	$6\frac{2}{3}$
14	20	5	48	$8\frac{1}{3}$

The above is for gable roofs and includes cost of scaffolding.

Hip Roofs.

Frieze.	Soffit.	Facia.	No. Feet.	Cost per Foot.
18-inch.	16-inch.	4-inch.	75	$5\frac{1}{3}$c.
22 "	20 "	$4\frac{1}{2}$ "	64	$6\frac{1}{4}$
28 "	24 "	5 "	52	$7\frac{3}{4}$
32 "	28 "	$5\frac{1}{2}$ "	40	10
34 "	32 "	6 "	32	$12\frac{1}{2}$

Cornice Mouldings.

Crown moulding, flat 2-inch.			800 feet per day, or		50c. per 100 feet.	
"	"	spring 4 "	500	"	80	"
"	"	" 5 "	445	"	90	"
"	"	" 6 "	365	"	$1.10	"
"	"	" 7 "	300	"	1.33	"
"	"	" 8 "	250	"	1.60	"

The cost of cornice moulding is ordinarily ½ a cent per lineal foot less than the number of inches in work—2 inch moulding, 1½ cents; 3-inch, 2½ cents, etc.

Bed moulding, flat, 1½-inch, 800 feet per day, or 50c. per 100 feet. Bed moulding, flat, 2-inch, 750 feet per day, or 54c. per 100 feet. Bed moulding, flat, 3-inch, 700 feet per day, or 58c. per 100 feet. Bed moulding, flat, 4-inch, 500 feet per day, or 80c. per 100 feet.

Cornice Brackets. Price per bracket, soft wood, all well worked—cost to put on building:

Perpendicular.	Horizontal.	Thickness.	Cost Plain	Moulded.	Plain.	Moulded.
Size, 16-inch.	12-inch.	$2\frac{1}{2}$-inch.	25c.	32c.	8c.	12c.
" 20 "	16 "	3 "	50	60	10	15
" 24 "	20 "	4 "	70	85	14	20
" 28 "	24 "	5 "	90	$1.06	16	25
" 30 "	28 "	6 "	$1.25	1.45	20	30

Plain panel moulding, two men will put on 300 ft. per day.
Foot moulding, " " 400 "

FLOORS.

								Cost per square.
Soft wood,	6 in.	wide,	without	bridging,	per joist,	800	sq. feet,	50c.
"	6	"	with	"	"	650	"	$61\frac{1}{2}$
"	4	"	without	"	"	600	"	$66\frac{2}{3}$
"	4	"	with	"	"	500	"	80
"	$3\frac{1}{2}$	"	without	"	"	400	"	$1.00
"	$3\frac{1}{2}$	"	with	"	"	300	"	$1.33\frac{1}{3}$

Two men will dress six squares of flooring after laying per day, or at a cost of 66⅔ cents per square.

If flooring is of hard wood, estimate per day two-thirds of above.

The number of feet, board measure, in a given floor is had by multiplying its length by its width and adding one-fifth for lapping. For flooring not matched omit the lapping. Two men will lay 1333 feet of plank flooring per day, or 30 cents per square, or will lay 2000 feet of common rough flooring, one inch stuff, or 20 cents per square.

Outside ceiling for wood buildings, average width, including beading and scaffolding, is worth, to put up, 80 cents per square. An average day's work for two men is five squares. Two men will dress, after laying the ceiling, five squares per day, or 80 cents per square. Ceiling over head is generally of wider stuff than outside ceiling; as there is no beading, and the workmanship is not so particular, two men will put up the same amount as of outside ceiling, including putting up and taking down scaffolding, or five squares at 80 cents per square.

Wainscoating. Wainscoating 2½ to 3 feet high, beaded, with ordinary capping, including dressing after putting up, is worth $2 per square. Two squares is a day's work for two men.

The same, 3 ft. to 4 ft. high, is worth, to put up, $1.33⅓ per square.

The same, with shoe and heavy caps, is worth $2.16 per square. The capping to wainscoating is ordinary moulding from 1½ in. by ⅞ to 2 in. by 1⅛ in.

Panel wainscoating, mill worked, ready to put up, including capping, shoe or base, is worth, for labor, $2 per square.

Hand-worked panel wainscoating is of so various a kind that definite prices of labor cannot be given without specifica-

tions. In a general way, the price per square for getting out and putting up will vary from $2 to $16 per square.

The above prices are for soft wood. For hard wood add 50 per cent.

Base-board. Plain base, 6 to 10 inches wide, put up before plastering, is worth 1 cent per lineal foot for labor. Two hundred feet is a good day's work for a man with mill-dressed lumber.

The same, put on after plastering, including putting on grounds, is worth 1½ cents per lineal foot.

Plain base, after plastering, with moulding, leveling, or capping by hand—mill-dressed stuff—is worth 2 cents per lineal foot to get out and place in the building.

Stairs. The wall string is the board with which the ends of the steps are fixed next to the wall.

The face-string is the board that carries the outer end of the steps and risers.

The *tread* is the horizontal board of the step.

The *riser* is the upright board of the step.

The *newell post* is the upright post at the lower step to receive the hand-rail.

The hand-rail is the rail supported by balusters. Balusters are small columns or pillars to support the rail.

The number of risers is found by dividing the distance from floor to floor by the height of the rise.

The height of each rise is found by dividing the distance from floor to floor by the height of the rise.

The number of treads is one less than the number of risers.

The width of each tread is found by dividing the risers by the number of treads and adding the projection.

Risers vary in height from 4 to 8 inches. Treads run from 8 to 14 inches.

It will be impracticable to give detail prices for all variety

of stair-work on account of the diversity of designs. We simply give a few as an illustration. The labor on rough, open stairs, for cellars or stables, when no risers are used, is worth 12½ cents per tread. Straight stairs between partitions, 2 feet 6 inches to 3 feet 6 inches long, with 6 inch to 9 inch tread, and 7 inch to 8 inch risers, are worth 25 cents per riser.

Winding stairs, same dimensions, 40 cents per riser. Open straight stairs, risers 6½ to 8 inches, treads 6 to 11 inches. Housed in wall string, mitred to face string; moulded nosing, including putting up turned balusters, and plain round or oval rail, with 6 inch to 8 inch turned newell post, are worth for labor 90 cents to $1 per riser.

The same stairs, winding, charge $2 per riser for the winding steps, and $1 for straight steps. Putting on brackets outside of stringer is worth from 3 to 8 cents per bracket.

The following is a list of the approximate prices of stair material:

Newell Posts. A turned newell post of cherry or black walnut, 5 inches in diameter, with cap, is worth $2.50; 6 inches, $3; and 8 inches, $3.50.

Octagon newell posts, walnut, oak, or cherry, with ornamental cap, 8 inches, $6; 9 inches, $6.50; and 12 inches, $8.50.

Newell posts veneered with fancy woods, with carving on plinth and cap, and moulded sunk panels, will vary from $15 to $50 each.

Balusters. Turned balusters, walnut or cherry, from 2 feet 4 inches to 3 feet, are worth, 1½ inches, 7 cents; 2 inches, 12 cents; and 2½ inches, 16 cents each. Oak and ash twenty per cent. less.

Fluted or octagon balusters, walnut or cherry, 2 inches, 16 cents; 2½ inches, 20 cents; 2¾ inches, 25 cents each.

Fancy balusters for high-priced stairs may run from 30 to 50 cents each.

Rails. Walnut or cherry. $3\frac{1}{2}$ inches, $12\frac{1}{2}$ cents; 4 inch, 15 cents; $4\frac{1}{2}$ inch, 16 cents; and 5 inch, 18 cents per lineal foot. Raised back rails, walnut or cherry, 4 inch, 22 cents; 5 inch, 27 cents; $5\frac{1}{2}$ inch, 32 cents; and 6 inch, 34 cents per lineal foot. Fancy raised back rails from 6 to 7 inches will vary from 40 to 60 cents per foot.

Doors. The price of doors may be had from any dealer's catalogue. The labor account is as follows: A fair day's work for one man is setting 5 door frames a day, and putting on ordinary casing. He will also hang and finish 5 doors per day, or 80 cents a door complete. The above is for 6 feet to 7 feet 6 inch doors, and $1\frac{5}{8}$ inch thick. From 7 feet 6 inch to 9 feet doors and $1\frac{3}{4}$ inch thick—a day's work of setting and casing 3 frames per day, or hanging and finishing 3 doors per day—\$1.33⅓ per door complete.

Moulding Door Casings. For 6 feet to 7 feet 6 inch doors, and 3 inch mouldings—one man will mould 6 door casings, two sides per day, or 33⅓ cents per door; with $4\frac{1}{2}$ inch mouldings, 5 doors per day, or 40 cents per door. Mouldings with two members about one-half above number, 7 feet 6 inches to 9 feet doors, single moulding two sides, 5 openings per day. The same, with double members to moulding, $2\frac{1}{2}$ openings per day.

Door frames when had from factory are cased both sides for inside doors and one side for outside doors.

Sliding Doors. The frames for a pair of sliding doors with double joint, including casings each side, are worth from \$2.50 to \$3 per frame.

The same, with segment top, will vary from \$5 to \$7.50; setting either one of the above frames, putting down the track, and lining the pocket is worth from \$2.50 to \$3 for

labor. Setting, hanging, and trimming a pair of sliding doors will take a man about 1¼ days, or $2.50 per door.

Folding Doors. The frame for a pair of folding doors with opening 5 feet by 8 feet 6 inches, with single joints, including casing each side, is worth from $2.25 to $3 per opening. Segment top, same size opening, $5 to $7. Setting the frame for a pair of folding doors will take a man three-quarters of a day, or $1.50 per frame.

Fitting, hanging, and trimming a pair of folding doors will take one man a day and a quarter, or $2.50 per door.

Moulding, sliding and folding door casings, square top opening 5 feet by 8 feet 6 inches on both sides, single member; a day's work is 4 openings per day, or 50 cents per door. If moulding is double member, two openings per day, or $1 per door. Segment top with same size of swing, the moulding will cost $2 per opening. Over the face of a square top, one man will put on the moulding with a single member in one-half a day, or $1 per opening. Double member one day, or $2 per opening.

Setting door frames in brick buildings will cost the same as for frame buildings.

Common Door Frames. Outside frames, with casings on one side for doors, from 2 feet 6 inches x 6 feet 6 inches to 2 feet 8 inches x 6 feet 8 inches, are worth from $1.75 to $2.50 each. The same for inside doors, with casing on both sides, are worth from $2 to $2.75.

Door Trimmings. Butts 3 x 3 inches, for cheap trimmings, are worth 6¼ cents per pair, and a common mortise or rim lock, with brown knob, 24 cents each; 3 x 3½ butts, 7 cents, and 3½ x 3½, 10 cents each; 4 x 4, 13 cents. A good mortise lock, with brown or white knobs, brass key, face, and bolt, is worth 45 cents. Outside door locks vary from 38 cents to $1 a pair; average price would be 50 cents.

Sliding door locks 4 x 5, brass key and face, $1 each. Iron track for door 3 cents per foot, brass track, 16 cents. A very good rabbited lock, without night works, $1.15; with night works, $2 to $3.50 each.

Screws for putting on above trimmings, 15 cents a gross. The labor account for trimming doors will be found under the head of doors.

Windows. The price of the sash, including glass and glazing for all sizes of windows, may be had from the dealers' catalogues. Window frames, factory made, simply have outside casings and jambs. One man will cut the openings and set five frames per day, of an average size, say 2 ft. 6 in. by 6 ft., in a frame building, and can set the same number in a brick building, or 40 cents per opening.

As the brick-work goes up the carpenter must plumb up the frames occasionally, so that a fair estimate would be both alike.

In larger openings, setting from two to four frames per day would be fair work, or from 50c. to $1 per window.

One man will case 12 windows per day of windows 2 ft. 6 in. by 6 ft., or one cent per lineal foot of the casing.

Moulding window casings, same price per foot as door casing.

For wood buildings, plain rail sash, 8 or 12 lights, with outside casings, an average price would be as follows:

8 x 10, $1; 10 x 12, $1.35; 10 x 14, $1.65; 10 x 16, $2.

With check-rail sash outside, casings: 8 x 10, $1.65; 10 x 12, $1.80; 10 x 14, $2; 10 x 16, $2.20; 10 x 18, $2.40.

Plain windows frames for brick buildings: 8 x 10, $2; 10 x 12, $2.10; 10 x 14, $2.35; 10 x 16, $2.05; 12 x 24, $3.50.

Box window frames: 8 x 10, $2.65; 10 x 12, $2.80; 10 x 14, $3; 10 x 16, $3.25; 12 x 24, $4.

The same frames, with segment outside and square inside, are worth 40 cents more.

Pantrys and Closets. In ordinary work of this kind one man will get out and put up 50 to 75 lineal feet of shelving 12 inches wide per day, or will make and put up five drawers 15 in. wide by 18 in. deep, including racks and fitting.

If the drawers are dovetailed, four is a day's work. Strips and hooks. One man can put 50 to 80 lineal feet of strips, and put on closet hooks, about 12 inches apart, in one day.

Porches. These differ so widely in design that prices per foot linear cannot be given without specifications, as they will vary from $1 a foot upwards. In an ordinary porch figure the sills and joists as in framing; also roof, labor, ceiling, and cornice the same as in other parts of the building, and charge for whatever extra work the design may call for.

Blinds. These are made and sold by the foot, measuring height of the window on one side only; 50 to 60 cents per lineal foot, including trimming and hanging, is a fair price. Inside blinds, O. G. panel or rolling slats, ordinary width, are worth $1 per foot, complete in the building. If inside blinds are of hard wood, they are worth from one and a half to double the price of pine.

Plastering. The number of yards is simply the area of all the walls and ceilings.

One hundred yards of plastering will require 1400 laths, 4½ bushels of lime, 18 bushels of sand, 9 pounds of hair, and 5 pounds of nails for two-coat work.

Three men and one helper will put on 450 yards, in a day's work, of two-coat work, and will put on a hard finish for 300 yards.

Retail cost of three-coat work for 100 yards of plastering:

Seven bushels of lime at 30 cents	$2 10
Four-fifths of a load of sand at $1.25	1 00
Nine pounds of hair at 65 cents	3 15
Five pounds of nails at $4\frac{1}{2}$ cents	22
Lathing, 100 yards at $2\frac{1}{4}$ cents	2 25
Plastering, 2 coats, 1 man $\frac{2}{3}$ of a day	2 00
Helper, 1-5 of a day	33
Hard finished, 1 day's work	3 00
Making mortar and scaffolding	1 50
Total cost	$16 00

Or, sixteen cents per yard.

Painting. Painting is done by the yard, and at the present prices of lead and oil, house painting in plain colors will cost on an average:

For one coat, 7 cents per yard; two coats, 14 cents per yard; three coats, 21 cents per yard.

One coat, or priming, will take for 100 yards of painting 20 pounds of lead and 4 gallons of oil. Two-coat work, 40 pounds of lead and 4 gallons of oil. Three-coat, the same quantity as two coats; so that a fair estimate for 100 yards of three-coat work would be 100 pounds of lead and 16 gallons of oil.

A day's work on outside of a building is 100 yards of first coat, and 80 yards of either second or third coat. An ordinary door, including casings, will on both sides make 8 yards to 10 yards of painting, or say, 5 yards to a door without the casings. An ordinary window $2\frac{1}{2}$ to 3 yards. Fifty yards of common graining is a day's work for a grainer and one man to rub in.

In measuring up outside work, use the rule for plain surfaces. In common painting run your tape-line over all the mouldings in and out, and this, with the width of the cornice multiplied by its length, will give the area. It is customary to add from one-third to one-half for the bracket painting. In painting blinds of ordinary size 12 is a fair day's work for

one coat, and 9 pounds of lead and 1 gallon of oil will paint them. In measuring up inside base, it is customary to reckon 9 inches in width and upwards to 1 foot as 12 inches.

Nails. One thousand feet of inch stuff will require 10 pounds of 10-penny nails, 1 square of siding or ceiling, 2½ pounds 8-penny, and the same for a square of roof boards or sheathing, and 1000 shingles will take 6 pounds of shingle nails.

Brick and Stone Work. A day's work in excavating and filling into cart or wheelbarrow is 11 or 12 cubic yards of common earth, or 7 to 8 yards of clay or coarse gravel, or 12½ to 14 cents per yard. In limestone or sandstone a day's work in quarrying will range from one-half to one cord of stone.

Stone Work. A perch is 16½ feet long, 1½ feet wide, and 1 foot high, and contains 24¼ cubic feet. In estimates 25 cubic feet is figured as a perch.

A perch in the wall contains about 22 cubic feet of stone and 3 cubic feet of mortar.

The waste ordinarily allowed in laying stone walls from the rock measurement is one-fifth.

A cubic yard of rubble masonary laid in the wall contains 1 1-5 cubic yards of undressed stone and one-fourth of a cubic yard of mortar.

Four perches or 100 cubic feet of wall will contain ordinarily 1 cord of stone or 128 cubic feet, 1 barrel of lime, or say 2½ bushels, and 5 barrels of sand.

A day's work for a mason's helper is moving 4 to 5 perches of stone, and mix and carry to the mason sufficient mortar to lay them.

A man will lay in one day from 4 to 5 perches of rubble masonry in sandstone, or 3 perches in limestone. In many locations sandstone is delivered for $1 per perch, and the

labor for laying in ordinary walls, including lime and sand, from 75 cents to $1 per perch.

Stone Ashlers. These are ordinarily 3 feet to 5 feet long, 1 foot high, and 4 to 6 inches thick.

The price of the rough stone will vary according to locality. The labor on ashlers, including setting, is per square foot as follows:

Fine posts,	hammerwork,	limestone,	28 cts.;	sandstone,	21 cts.
Medium	"	"	22 "	"	17 "
Rough	"	"	15 "	"	12½ "

Freestone ashlers, sawed, are furnished at the mills for 20 to 30 cents per square foot, and caps and sills for ordinary windows and doors from $1.15 to $1.50 each.

Brick-work. The labor and material of brick-work are estimated by the 1000 brick. In measuring up brick walls it is not customary to deduct for openings. To ascertain the number of bricks in a wall: First obtain the number of superficial feet, and multiply this by seven for a 4-inch wall—by 14 for an 8-inch wall—21 for a 12-inch wall—and 28 for a 16-inch wall. If thicker than 16 inches, for each additional 4 inches in thickness add 7 bricks per square foot.

One thousand five hundred brick is an average day's work for outside and inside walls, and we take three-quarters of a barrel of lime and 9 bushels of sand to make the mortar. The number of brick a mason will lay in a day on a plain wall depends largely upon its thickness. On 8-inch work 1200 to, 1400; on 12-inch work, 1500 to 2000, and on 16-inch work, 2000 to 2500; veneered work or single-back walls attached to wood-work is much slower, froom 400 to 600 brick is regarded a day's work; this includes tying the brick with nails to the framework, or sheathing.

The following is given as an illustration of the cost of furnishing and laying 1500 brick, or one day's work.

1500 brick at $6 per M.	$9 00
$\frac{3}{4}$ barrel of lime at $1	75
9 bushels of sand at 5 cents.	45
1 day's work for mason.	2 00
1 day's work for helper.	1 25
Total.	$13 45

Or $8.96 per M.

Chimneys. Common flues and ordinary chimneys are worth from 40 to 75 cents per running foot, including labor and material. In large chimneys with fire-places, get the number of brick, charge for lime and sand the same as in brick walls, and estimate the labor at double the price of plain walls of same thickness.

Plumbing. In plumbing for bath-rooms and closets 1¼-inch pipe is used for water, ⅝-inch for supply, and 4-inch iron pipes for soil-pipe. An average price would be for material and putting in the building: 1¼-inch pipe, lead 33⅓ cents per foot; ⅝-inch pipe, lead, 28 cents per foot, and soil-pipe 30 cents per foot.

Bath-tubs will vary in price from $10 to $15; double bath-cocks, $10 to $12.50; single, $1.50 to $2.75; wash-bowl cocks, from $1.75 to $2.50.

A fair price for a cornice wash-bowl, marble, with stop-cocks and enclosed with casings, including connections with pipes, will vary from $9 to $15; water-closet basins and connections, $4 to $6.

It must be understood that the foregoing prices are only approximately correct.

SCHEDULE OF BUILDERS' PRICES.

The prices given in this schedule are as nearly as possible correct at the time of compilation; but as prices are continually fluctuating they are not to be relied upon as *absolutely correct.* One column is left blank, so that correct prices can be inserted in pencil and changed to suit fluctuation at any time. By the above arrangement the prices can be made correct for any locality at any time.

The prices given include Builder's Profit.

EXCAVATORS' WORK.

	Approximate Price.	Correct Price.
Including all necessary plank and tools required for carrying on the work, shoring, etc., bracing where required, and keeping the excavation clear of all surface water caused by rain until the earth, etc., has been removed to the depth required.		
Excavating for basements and large areas, and throwing out to a height of five feet, and filling into barrows, carts, or other vehicles.		
Vegetable earth..................per cubic yard	0.12	
Loam (sand and clay mixed)...... " "	0.17	
Clay............................ " "	0.23	
Earth mixed with gravel.......... " "	0.30	
Work requiring blasting........... " "	1.10	
Mud in a slush state.............. " "	1.35	
Removing 30 yards with wheelbarrows or carts, depositing and returning.		
Soft earth or loam......... per cubic yard, extra	0.07	
Clay, gravel or mud..............per cubic yard	0.09	
Leveling earth, etc., from carts or barrows, without throwing.		
Soft earth.......................per cubic yard	0.04	
Clay or gravel.................... " "	0.05	
Filing at backs of walls and ramming.		
Soft earth....................... " "	0.12	
Clay or gravel.............. ..... " "	0.18	

EXCAVATORS' WORK (*Continued*).	Approximate Price.	Correct Price.
Leveling and trimmming slopes, etc.		
Soft earth....................per cubic yard	0.07	
Clay or gravel.................... " "	0.09	
Ramming loose earth.		
Soft earth in layers.............. " "	0.07	
Clay, gravel, etc................. " "	0.09	
Clay puddle.		
Tempering and spreading 9 in. thick " "	1.30	
" " " 12 " " "	1.10	
Removing a distance of 225 yards lineal, and returning after depositing the load.		
Soft earth....................per cubic yard	0.12	
Clay, sand, or gravel.............. " "	0.14	
For each additional 225 yards, add..............	0.12	

MASONS' WORK.

	Approximate Price.	Correct Price.
Rubble masonry in foundations.		
Built dry in courses to foundations etc., cubic foot	0.13	
" with mortar to " " "	0.17	
" " " above " " "	0.18	
" when beds are horizontal " "	0.17	
All work should be measured by the foot cube, and the price regulated according to the thickness of the wall.		
Superior rubble.		
Built with large-sized stone, with beds horizontal and joints vertical, or oblique, fitting close, without spawls in face, rough finished, and fair and neatly pointed. ....per cubic foot	0.23	
Add to the above, if executed to rough arches, as to tanks, vaults, tunnels, etc., with radiating joints, finished fair.............per cubic foot	0.35	
Superior face work to be measured and paid for extra.		
Face work to rubble masonary, per super. foot.		
Rough hammer dressed, punched, or pricked face, straight, or curved above 10 feet radius..	0.10	
Clear, do. do. neatly hammer dressed, punched or pricked.........................	0.14	

MASONS' WORK (*Continued*).	Approximate Price.	Correct Price.
Rough rock face work with pitched joints, straight or curved, above 10 ft. radius................	0.45	
Add to any of the above items for waste of stone, for oblique or battered face, or curved work under 10 ft. radius..........................	0.15	
Sinking reveals for window or door frames, or similar work, actual sinking only 2 or 3 inches deep.....................................	0.45	
Repairs, cubic foot, including all materials required and removing all rubbish arising from the work.		
Taking down old rubble masonry, cleaning the stone and rebuilding, under 40 cubic feet, in any quantity................................	0.20	
Taking up old rubble masonry in foundations, culverts, etc. Cleaning, moving, and piling the stone not exceeding 30 yards distant, and removing rubbish..........................	0.09	
Taking down rubble masonry of any kind in superstructure—i.e., not exceeding 30 yards distant....................................	0.06	
Rebuilding masonry in superstructure, furnishing labor and mortar only....................	0.10	
Cutting openings in walls of rubble masonry of any kind for doors, windows, ventilators, etc., where the quantity does not exceed 50 cubic feet....................................	0.05	
Making good to jambs, sills, and arches of openings of any kind with old stone, labor and mortar....................................	0.12	
Ashler work, per cubic foot.		
Ashler faced work, straight or curved, above 10 feet radius to rubble or brick walling, in level courses from 10 to 16 inches high, 6 inches on beds, vertical joints and beds roughly punched or pricked, bedded flush, and joints neatly pointed and cleaned down....................	0.65	
Add to above if beds and joints are to be neatly punched or axed three inches back from face..	0.06	
Add for curved work under 10 feet radius, labor only....................................	0.12	
Add, if executed in chimney shafts, vaults, and similar work, with radiating joints............	0.12	
Stone from quarry, carted a distance of 3 miles.		
Common rubble..................per 1000 lbs.	0.55	
Selected bed stones..............................	0.80	

MASONS' WORK (*Continued*).		Approximate Price.	Correct Price.
Suitable for plain ashler, not over 6 inches thick, per cubic foot		0.30	
do. do. 12 inches thick, per cubic foot		0.48	
Above these sizes, from		1.00	
to		2.25	
The following are for prices of labor only, for straight or curved work over 10 feet radius, including setting and cleaning down, per foot superficial.			
Plain work to beds and joints	limestone	0.22	
	sandstone	0.27	
	granite	0.55	
Plain work, rubbed or combed face.	limestone	0.35	
	sandstone	0.35	
	granite	0.62	
Plain work, sunk $1\frac{1}{2}$ inches deep	limestone	0.62	
	sandstone	0.50	
	granite	1.04	
Rough or rock pitched face-work and horizontal joints	limestone	0.25	
	sandstone	0.25	
Rough or rock pitched face-work, drafted on face	limestone	0.22	
	sandstone	0.12	
Rough punched, or pricked face	limestone	0.12	
	sandstone	0.10	
	granite	0.22	
Fine punched or pricked face	limestone	0.18	
	sandstone	0.12	
	granite	0.44	
Plainly chiseled, or single axed face.	limestone	0.32	
	sandstone	0.30	
	granite	0.65	
Finely chiseled, or double-axed face.	limestone	0.42	
	sandstone	0.38	
	granite	0.80	

NOTE.—(1). When the work in a specification differs in description to the work described in any of the above items, the necessary allowances must be made for the difference in cost. The ashler facing described is the ordinary plain facing.

(2.) In measuring ashler facing the average width of the beds of the stretches is only to be taken for ashler, and the excess paid for as rubble backing. In ashler facing, if required to be backed by brickwork, the back joints of headers and stretchers are to be roughly punched fair and square, and to be paid for as rough hammer-dressed work.

(3). Arches or lintels over openings in ashler facing, to be paid for as stone in block, adding the work thereon. The returns of jambs and reveals to openings, where no specific dressings are provided, are to be measured for plain and sunk work.

MASONS' WORK (*Continued*).		Approximate Price.	Correct Price.
Workmanship in cutting (per foot lineal) in either limestone or sandstone.			
Beading, single quirk up to 4 inches girth	straight	0.12	
	circular	0.18	
Chamfering or weathering, from 2 in. up to 3 inches	straight	0.26	
	circular	0.32	
Chiseled drafted margins, from $\frac{3}{4}$ inch to 1 inch wide	straight	0.18	
	circular	0.22	
Fluting or reeding, not exceeding 3 inches wide	straight	0.22	
	circular	0.28	
Grooving, covering fluting or reeding less than 3 inches girth	straight	0.22	
	circular	0.28	
Mouldings less than 4 inches girth		0.28	
Nosings 3 inches or less girth		0.22	
Throating, angular, semicircular or arris cut		0.17	
Sunk rebate, not exceeding 3 inches girth	straight	0.22	
	circular	0.28	
Rounded corners or angles in stone, not exceeding 3 inches thick, 6 inches radius and under	straight or sq. edge	0.38	
	circ'r or rounded	0.55	
NOTE.—The prices to the above items include all returned angles, stoppings, and all mitres, internal or external, etc., whenever they occur.			
Letting in with lead, fixing, etc., each including all materials.			
Letting in balusters or other work, holes 1 inch or less in diameter, and from 2 to 3 inches in depth	with molten lead	0.12	
	with cement	0·04	
Letting in as above described, bases of columns, standards, etc., 2 to 4 inches diam. and 4 inches deep	molten lead	0.55	
	cement	0·07	
Letting in as last described, holes from 4 to 6 inches in diameter	molten lead	0.70	
	cement	0.12	
Letting in as before described, holes from 6 to 9 inches in diam.	molten lead	0.80	
	cement	0.14	
Same, holes from 9 to 12 inches in diameter	molten lead	0.95	
	cement	0.15	
Letting in clamps of any kind from 1 to $1\frac{1}{2}$ inches section, per lin. in.	with lead	0.06	
	cement	0.03	
Letting in door scrapers, lamp irons, locks, latches, staples, or similar work, each	with lead	0.25	
	cement	0.10	

MASONS' WORK (*Continued*).		Approximate Price.	Correct Price.
Sinking mortises or housings to receive ends of door posts, or sockets, or similar work, per lin. inch		0.22	
Boring rail pipe, or bolt holes up to 1½ inches diam., and 6 inches deep, labor only		0.09	
Letters or figures neatly and deeply cut, per lin. inch		0.07	
Door sills and steps, square, of limestone or sandstone not exceeding 6 ft. in length, per foot lineal. Labor and materials.			
Rough punched top of sill, front and back joints squared, 3 inches in depth, bed and rough ends		0.65	
Rough punched tread and riser, bed and back joints squared, 13 inches, back and ends rough		0.75	
Rough punched all round, including the ends		0.80	
Plain chiseled tread and riser, joints, etc., as above cleanly punched		0.95	
Plain chiseled tread and riser and end, the bed and back riser cleanly punched		1.05	
Window sills, not exceeding 6 feet in length, per lin. foot. Labor and materials.			
Neatly and finely punched, sunk, weathered, throated and back rebated, and finished complete	12 x 6	0.78	
	16 x 7	1.05	
	20 x 8	1.30	
Plain chiseled, tooled or single axed, as above	12 x 6	0.82	
	16 x 7	1.09	
	20 x 8	1.40	
Neatly chiseled, tooled, or double axed.	12 x 6	0.95	
	16 x 7	1.15	
do. do. as above	20 x 8	1.40	
Foundations for paving, etc., per superficial yard.			
Forming foundations for paving or for roads, with stone clippings, coarse gravel, or other suitable material, including spreading and leveling surface to the average depth of 12 inches		0.28	
do. do. do. 9 "		0.23	
do. do. do. 6 "		0.18	
Concrete foundations.			
Concrete foundations for any purpose, filled or shot in, raked, bevelled, and rammed, in layers not exceeding 12 inches in depth, per cub. y'd.		2.70	
As above, and not exceeding 9 inches in depth, per yard superficial		3.10	
do. do. 6 inches deep, per yard super.		3.70	

MASONS' WORK (*Continued*).		Approximate Price.	Correct Price.
Flag pavements or hearths.			
Of the best quality, not exceeding twenty-five feet superficial in one flag*..........per yd. super.			
Rough, self-faced or scrabbled, and roughly sq'red.	$2\frac{1}{2}$ in. thick or under	1.80	
	3 to $3\frac{1}{2}$ " "	2.40	
	4 to $4\frac{1}{2}$ " "	2.90	
Smooth, self-faced, or scrabbled, and roughly faced.	$2\frac{1}{2}$ in. thick or under	2.10	
	3 to $3\frac{1}{2}$ " "	2.60	
	4 to $4\frac{1}{2}$ " "	3.10	
Neatly punched face and squared.................	$2\frac{1}{4}$ in. thick or under	3.05	
	3 to $3\frac{1}{2}$ " "	3.30	
	4 to $4\frac{1}{2}$ " "	4.30	
Plain chiseled, tooled, or single axed, squared.....	$2\frac{1}{2}$ in. thick or under	3.60	
	3 to $3\frac{1}{2}$ " "	4.10	
	4 to $4\frac{1}{2}$ " "	4.60	
SUNDRIES.			
Stone as sold in New York at cargo rates, at this date, 1882.			
Amherst freestone, in rough, No. 1..per cub. foot		1.00	
" " " No. 2.. " "		0.95	
" No. 1, light drab.......... " "		0.95	
Berlin freestone, in rough......................		1.00	
Berea freestone, in rough......................		1.00	
Brown stone, Portland, Ct......................		1.35	
Brown stone, Belleville, N. J		1.35	
Granite, rough..................................		1.25	
Canaan marble..................................		1.50	
Carlisle, (Corsehill) Scotch.............per foot.		1.00	
Dorchester, N. B., stone, rough......... "		1.00	
Bay of Fundy, Wood Point, brown..............		1.00	
" Mary's " "		1.00	
" " olive..............		1.00	
Native stone.			
Common building stone................per load		3.00	
Base stone, $2\frac{1}{2}$ feet in length........per lin. foot		0.50	
" " 3 " "		0.60	
" " $3\frac{1}{2}$ " "		0.80	
" " 4 " "		1.00	
" " $4\frac{1}{2}$ " "		1.25	
" " 5 " "		1.50	
" " 6 " "		3.00	

*NOTE.—Add to the above, if rubbed fair and smooth to order, according to the hardness of the stone and work to be done. The flags to be of a uniform thickness, bedded flush, and solid throughout the whole area; the joints set close, flushed (with cement or mortar) from bottom to top and neatly pointed, and the top surface properly dressed off.

MASONS' WORK (*Continued*).	Approximate Price.	Correct Price.
Limes per barrel, cargo rates.		
Lath, cargo rate........................per M	2.30	
Rockland, common..........................	1.20	
Rockland, finishing.........................	1.20	
State, common, cargo rate...............per bbl.	1.20	
State, finishing................................		
Ground..	1.20	
Add 25c. to above figures for yard rates.		
Cements per barrel, cargo rates.		
Rosendale..............................per bbl.	1.25	
Portland, Saylor's American..................	2.65	
Portland (English)................................	3.50	
Portland Lafarge..................................	3.60	
Portland K. B. & S................................	3.35	
Portland Burham	3.00	
Lime of Teil...	2.50	
Lime of Teil..............................per ton	18.06	
Roman ....per bbl.	3.40	
Keene's & Martin's coarse.......................	6.50	
Keene's & Martin's fine..........................	10.70	

BRICKLAYERS' WORK.

		Approximate Price.	Correct Price.
Materials to be of the best quality, the Contractor to provide all labor in hoisting and setting, and all implements necessary to carry on the work.			
Basis of calculation.			
Bricks, per 1000, best quality, full size,	per 1000	10.00	
Wages of a bricklayer..................	per day	3.50	
Wages of a laborer................	"	2.00	
Brickwork in walls as usually laid in good work....................	per 1000	15.00	
	per ft. cube	0.30	
do. do. laid in American cement........................	per 1000	19.00	
	per ft. cube	0.40	
Brickwork, etc., to covering of arches including all cutting, etc., in lime mortar	per 1000	4.00	
	per ft. cube	0.45	
do. do. to ovens and coppers do.	" "	0.48	
Add if elliptical....................	" "	0.52	

BRICKLAYERS' WORK (*Continued*).	Approximate Price.	Correct Price.
Gauged arches, rubbed only....................	0.16	
do. cut and set in putty.............	0.32	
Paving with bricks laid flat in sand..per ft. super.	0.52	
do. do. on edge in mortar " "	1.05	
do. do. flat in cement.... " "	0.78	
do. do. on edge in mortar " "	1.55	
DRAIN PIPES.		
Excavating 4 feet deep and filling in—labor only.		
4 inch drain pipes, laying and jointing in cement....... ....per y'd lin.	0.80 to 1.10	
6 inch do. do. do. do. " "		
9 inch do. do. do. do. " "		
12 inch do. do. do. do. " "		
SUNDRIES.		
Terra cotta chimney tops.		
Set in cement................. 2 ft. high	3.00	
do. 2 " 3 in. "	3.25	
do. 2 " 6 in. "	3.50	
do. 3 " "	7.00	
Ornamental, Elizabethian, and Gothic Chimney tops charged extra.		
Terra cotta wall coping...................per ft.	0.60	
do. cresting...................... "	0.45	
do. mouldings................... "	1.75	
do. diaper tiles.....................each	1.50	
Pointing.		
Flat joints, in ash mortar or cement, per ft. super.	0.05	
do. to chimney shafts...... " "	0.06	
Stopping and tuck pointing to old fr'nts " "	0.08	
Brickwork colored and drawn...... " "	0.10	
Tuck pointing new work before the scaffolding is removed.......................................	0.06	
$1\frac{1}{4}$ inch wide hoop iron, tarred and sanded, laid in walls at per yard running for every dress...	0.06	
Cutting to rakes or ramp in brickwork..ft. super.	0.06	
do. to 4 inch splays..........per ft. running	0.06	
Birds' mouth splays............... " "	0.07	
Sash, doors and frames, bedded and pointed, each	0.30	
do. do. do. do. large size	0.45	
Taking down old brickwork, cleaning and piling the bricks within a distance of 75 yards, and removing rubbish 50 or 75 feet....per ft. cubic	0.04	

BRICKLAYERS' WORK (*Continued*).	Approximate Price.	Correct Price.
Rebuilding brickwork from old bricks, mortar and workmanship only............per cub. ft.	0.10	
Firebricks..........................per 1000	35.00 to 50.00	
SUNDRIES.		
Wages.		
Laborer..................................	2.25	
Bricklayer................................	3.50	
Brick—cargo afloat.		
Pale..........................per M.	5.00	
Jerseys..................................	9.00	
Long Island..............................	9.25	
Up-Rivers................................		
Haverstraw Bay, 2ds......................	9.37½	
Haverstraw Bay, 1sts.....................	9.50	
Favorite brands..........................		
Hollow fire clay bricks..................	9.25	
Fronts.		
Croton and croton points—brown.........per M.	11.25	
do. do. —dark................	13.25	
do. do. —red.................	13.25	
Philadelpeia.............................	35.00	
Trenton..................................	35.00	
Baltimore................................	45.00	
Clark's Ottawa White.....................	25.00	
Yard prices 50c. per. M higher, or, with delivery added, $2 per M for hard and $3 per M for front brick. For delivery add $5 on Philadelphia, Trenton and Ottawa, and $6 on Baltimore.		
Fire brick.		
Welsh....................................	40.00	
English..................................	45.00	
Silica, Lee-Moor.........................	40.00	
Silica, Dinas............................	65.00	
White enameled, English size............per M	100.00	
do. do. domestic size..................	85.00	
Warm buff facing, domestic size..........	55.00	
American, No. 1..........................	40.00	
American, No. 2..........................	35.00	
These prices are wholesale and for large quantities. Builder's profits to be added.		

BRICKLAYERS' WORK (*Continued*).		Approximate Price.	Correct Price.
Schedule of prices of plain, molded, ornamental and colored bricks, manufactured by the Peerless Brick Company, Philadelphia, per 100.			
Numbers.			
Those marked thus (*) have RETURNS.			
1*, 2*, 6*, 7*, 20, 31, 40, 41, 42, 55, 57*, 58*, 58, 59, 63*, 90.................	red	4.00	
	colored	5.50	
3, 4, 11, 16, 17, 49, 50, 56*, 72*, 91....	red	4.50	
	colored	6.00	
5*. 12, 15, 18, 19, 20*a*, 22*, 23*, 24*, 29, 30, 60, 62*, 73*, 92, 94, 95, 96*, (Pebbled)...........................	red	5.00	
	colored	6.50	
8, 9, 20*b*, 21, 25, 26, 35*, 39, 47, 68*, 74	red	5.50	
	colored	7.00	
10, 13*, 14*, 27, 28, 38, 61, 66, 70, 93,	red	6.00	
	colored	7.50	
32, 36, 37*, 202*.....................	red	7.00	
	colored	8.50	
36, 37, with black bevels.............	red	9.00	
	colored	10.50	
67..................................	red	7.50	
	colored	9.00	
80, 81, 82, 83, 84, 85, 200, 201, 203, 264, 265, 266, 272......................	red	10.00	
	colored	15.00	
86, 270, 271	red	40.00	
	colored	50.00	
269*, 273, complete..................	red	30.00	
	colored	40.00	
87, 88...............................	red	50.00	
	colored	65.00	
Returns.			
8 × 8 × 4 inches.................each	red	0.25	
	colored	0.35	
8 × 8 × 2 " .... "	red	0.17	
	colored	0.20	
8 × 4 × 2 " No extra charge.			
Colored and plain.			
Buff, plain............................	colored	4.50	
Brown "	"	5.00	
Drab "	"	5.00	
Gray "	"	5.00	
White "	"	5.00	
Black "	"	10.00	
The above are all colored throughout.			

BRICKLAYERS' WORK (*Continued*).		Approximate Price.	Correct Price.
Black—on face........................	colored	3.00	
" on face and head................	"	3.50	
" on two heads....................	"	3.50	
" on face and two heads...........	"	4.00	
" on face and flat................	"	4.00	
" on face, heads and flat.........	"	5.00	
Sage, olive, etc., on colored body........	"	6.50	
Red pressed, 10 inches long.....................		3.00	
Red, extra fine pressed, standard size......	per M		
Red voussoirs, 1, 1½, 2, 2½, 3, 3½, and 6 feet radius, plain or bonded..............................		4.00	
Red voussoirs for flat arch, 10 in. deep, 3 ft. opening, radius, 3½ ft..........................		10.00	
Red voussoirs No. 60, with skew.....	red	7.50	
	colored	9.00	
Bricks for carving..................	red	4.00	
	colored	6.50	
Hexagonal, 8×8 (red and brown.....	red	4.00	
	colored	6.00	

☞ The numbers refer to an illustrated catalogue.

Ornamental Bricks—Blacked or tinted on the relief or intaglio parts—to order. See Nos. 36, 37 and 272.

PLASTERERS' WORK.

	Approximate Price.	Correct Price.
Including all labor, scaffolding, materials, tools, etc.		
Lathing only....................per yard super.	0.10	
Lath and plaster, one coat........ " "	0.17	
do. do. and set with fine stuff " "	0.22	
do. do. two coats and float do. " "	0.26	
Add, if work is gauged in plaster-of-Paris........	0.06	
Rendering on brick wall one coat, per yard super.	0.10	
do. do. floating and set, " "	0.20	
do. do. two coats and set with fine stuff..........................per yard super.	0.25	
do. do. with American cement one coat..........................per yard super.	0.22	
do. do. one part cement and one part sand..........................per yard super.	0.19	
do. do. two parts sand and one part cement..........................per yard super.	0.16	

PLASTERERS' WORK (*Continued*).	Approximate Price.	Correct Price.
Rough-casting.		
Rough-casting on brick or stone, one coat with lime and fine gravel............per yard super.	0.12	
do. do. two coats with lime and fine gravel........................per yard super.	0.18	
Cornices, mouldings, etc.		
*Plain cornices and mouldings, per inch girth, and foot running	0.2½	
Quirks run in plaster to wood bead, per inch girth and per foot running.................	0.2½	
Enrichments in plaster.		
Members cast solid and trimmed, per inch girth	0.04	
do. undercut, per inch girth...............	0.04	
Enriched soffits...................	†	
do. very rich and full.............	†	
Wreaths of laurel leaves......................	†	
do. oak leaves and arrows...	†	
Cast flowers, or pateres.		
According to size...............per inch diam.	0.10 to 0.30	
SUNDRIES		
Pointing round winter sashes or doors with lime and putty, plaster-of-Paris................each	0.40	
Coloring.		
Stone, buff, or salmon color, once done, yd. super.	0.10	
do. do. twice done, "	0.12	
French grey, blue or lemon color, once done "	0.10	
do. do. twice done "	0.15	
Limewhite and whitewashing, per square of 100 *superficial feet.*		
Limewhite, once done..........................	0.10	
do. twice done......................	0.20	
Whiting, with whiting and size, once done......	0.10	
do. do. twice done......	0.20	
Scraping off old whitewash and stopping old walls to receive new whitewash...............	0.15	

* This price also includes the dubbing out and putting up of rough brackets whenever these are necessary, and the extra lathing.

All mitres over four in number, are to be charged each at the price of a foot running of moulding, except in halls, or small rooms under 14 x 16, then all the mitres should be paid for extra.

† The prices vary according to the quantity and depth of enrichment, and the nature of designs.

PLASTERERS' WORK (*Continued*).	Approximate Price.	Correct Price.
Per running foot.		
Whiting, with whiting and size, plain cornices, once done..	0.01	
do. do. do. twice done	0.04	
Each.		
Stopping holes in walls under 3 inches square, including drawing nails.......	0.02	
Stopping holes in colored walls, including coloring to match..	0.03	
Repairing plastering on walls and ceilings in patches not exceeding 2 feet superficial, including hacking off old..........................	0.15	
do. on walls, including coloring to match..	0.18	
Add extra for gauging with plaster-of-Paris......	0.03	
Hair.		
Cattle........................per bushel of 7 lb.	0.18	
Goat...........................	0.28	
Per yard superficial.		
Taking down old lathing and plastering on walls and ceilings and removing rubbish......	0.06	
Taking down old rendering or rough-casting and removing rubbish, including wetting, dubbing out, etc., to receive new plastering............	0.06	
Taking down old plastering on lathed walls or ceilings without renewing the lathing, including renailing the laths where necessary, and removing rubbish..........................	0.05	
Materials and day work—working day 10 *hours.*		
Plasterer..............................per day	4.00	
Laborer............................... "	2.25	
Boy.................................. "	1.25	
Pine laths..........................per bundle	0.30	
Hair mortar......................per foot cube	0.35	
Fine stuff...... .... "	0.60	
Plaster-of-Paris........................per barrel	2.00	
Whiting...............................per lb.	0.03	
Hair dried and thrashed................. "	0.06	
Size.......... ....per gallon	0.20	
Blue black ....per lb.	0.10	
Yellow ochre............................ "	0.04	
Venetian red............................ "	0.05	
Indigo.......... .... "	1.00	
English umber........................... "	0.25	
Prussian blue........................... "	1.20	

PLASTERERS' WORK (*Continued*).	Approximate Price.	Correct Price.
Plaster-of-Paris—wholesale.		
Duty—20 per cent. ad. val. on calcined; lump free.		
Nova Scotia, white........................per ton	3.50	
Nova Scotia, blue.......................... .	3.25	
Calcined, Eastern and city................per bbl.	1.75	
Calcined, city casting..........................	1.90	
Calcined, city superfine	2.25	

Plastering is generally measured by the yard superficial. Openings of less extent than seven yards are not deducted. Returns of chimney breasts, pilasters, or angles less than 12 inches wide, measure 12 inches. Baseboards, 6 or less inches wide, are not deducted. In closets, add one-half to the measurement. Circular or elliptical work, charge two prices, and for domes or groined ceilings, three prices. For each 12 feet in height above the first 12 feet add 6 per cent. extra. Cornices and centre-pieces in buildings more than 18 feet high in the first story, should have five per cent. added to cover scaffolding etc. Centre-pieces, panelling, and extra stucco work will be charged as may be agreed upon.

CARPENTERS' AND JOINERS' WORK.

	Approximate Price.	Correct Price.
Average wages in the United States and Canada in 1882.............................. per day	2.75	
Wages in New York..................... "	3.50	
Price of Lumber.		
Prices for yard delivery, average run of stock. Allowance must be made on one side for special contracts, and on the other for extra selections.		
Pine, very choice and ex. dry..........per M. ft.	70.00	
" good..	60.00	
" shipping box..............................	22.50	

CARPENTERS' AND JOINERS' WORK (*Continued*).	Approximate Price.	Correct Price.
Pine, common box	20.00	
" common box, ⅝	18.00	
" tally plank, 1¼, 10 in., dressed ... each	0.50	
" tally plank, 1¼ 2d quality	0.38	
" tally planks, 1¼, culls	0.30	
" tally boards, dressed, good	0.32	
" tally boards, dressed, common	0.28	
" strip boards, culls, dressed	0.25	
" strip boards, merchantable	0.20	
" strip boards, clear	0.26	
" strip plank, dressed clear	0.35	
Spruce boards, dressed	0.25	
" plank, 1¼ inch ... each	0.26	
" plank, 2 inch ... each	0.40	
" plank, 1¼ in., dressed	0.30	
" plank, 2 in., dressed	0.45	
" wall strips	0.16	
" timber ... per M ft.	25.00	
Hemlock boards ... each	0.18	
" joist, 2½ x 4	0.17	
" joist, 3 x 4	0.20	
" joist, 4 x 6	0.44	
Ash, good ... per M ft.	55.00	
Oak	65.00	
Maple, cull	30.00	
" good	50.00	
Chestnut	52.00	
Cypress, 1, 1½, 2 and 2½ in	40.00	
Black walnut, good to choice	125.00	
" ⅝	100.00	
" selected and seasoned	175.00	
" counters ... per ft.	0.28	
" 6 x 5	160.00	
" 6 x 6	160.00	
" 7 x 7	180.00	
" 8 x 8	180.00	
Cherry, wide ... per M ft.	120.00	
" ordinary	80.00	
Whitewood, inch	50.00	
" ⅝ inch	40.00	
" ⅝ panels	50.00	
Shingles, extra shaved pine, 18 in ... per M	6.00	
" extra shaved pine, 16 in	4.00	
" extra sawed pine, 18 in	5.00	
" clear sawed pine, 16 in	4.00	

CARPENTERS' AND JOINERS' WORK (*Continued*).	Approximate Price.	Correct Price.
Shingles, cypress, 24 x 6	20.00	
" cypress, 20 x 6	12.00	
Yellow pine dressed flooring .... per M ft.	40.00	
Yellow pine girders	40.00	
Locust posts, 8 feet .... per foot	0.20	
" posts, 10 feet	0.25	
" posts, 12 feet	0.34	
Chestnut posts .... per ft.	0.03½	
Cargo rates 10 per cent. off.		
FOREIGN WOODS—DUTY FREE.		
Cedar.		
Cuba and Mexican small .... per super. ft.	0.07½	
" " medium	0.09½	
" " large	0.11	
Florida .... per cubic foot	0.75	
Mahogany.		
Cuba, small	0.07	
" medium	0.09	
" large	0.11	
" shaded or figured	0.15	
St. Domingo, crotches, ordinary to good, per superficial foot	0.20	
St. Domingo, crotches, fine	0.30	
" logs, small	0.08	
" logs, large	0.14	
Mexican, large	0.15	
" medium	0.11	
" small	0.08	
Honduras	0.12½	
Rosewood, ordinary to good .... per lb.	0.04½	
" good to fine	0.08	
Honduras .... per ton	20.00	
Satinwood .... per superficial foot	0.75	
Tulipwood .... per lb.	0.07	
Lignumvitæ, 8 and 11 inch .... per ton	50.00	
" other sizes	25.00	
DOORS, WINDOWS AND BLINDS.		
Doors, raised panels, two sides.		
2.0 x 6.0 .... 1¼ inch	1.04	
2.6 x 6.6 .... 1¼ "	1.38	
2.6 x 6.8 .... 1¼ "	1.44	
2.8 x 6.8 .... 1¼ "	1.50	

CARPENTERS' AND JOINERS' WORK (*Continued*).		Approximate Price.	Correct Price.
Doors, moulded.			
2.0 x 6.0	1¼ inch	1.70	
2.0 x 6.6	1¼ "	1.79	
	1½ "	2.24	
2.6 x 6.8	1¼ "	2.07	
	1½ "	2.62	
2.6 x 6.10	1¼ "	2.11	
	1½ "	2.68	
2.6 x 7.0	1¼ "	2.27	
	1½ "	2.71	
2.8 x 6.8	1¼ "	2.16	
	1½ "	2.75	
	1¾ "	3.84	
2.8 x 7.0	1¼ "	2.35	
	1½ "	2.83	
	1¾ "	3.99	
2.10 x 6.10	1¼ "	2.28	
	1½ "	2.92	
	1¾ "	4.00	
3.0 x 7.0	1¼ "	2.54	
	1½ "	3.09	
	1¾ "	4.39	
Outside blinds.			
Per lineal foot, up to 2.10 wide		0.25	
Per lineal foot, up to 3.1 wide		0.27	
Per lineal foot, up to 3.4 wide		0.30	
Inside blinds.			
Per lineal foot, 4 folds, pine		0.60	
Per lineal foot, 4 folds, ash or chestnut		0.96	
Per lineal foot, 4 folds. cherry or butternut		1.28	
Per lineal foot, 4 folds, black walnut		1.36	

The foregoing prices are wholesale quotations; the following, unless otherwise specified, are manufacturers' prices. A liberal discount is always allowed to contractors.

It is usual in estimating, to charge retail prices, and then add contractor's percentage on whole amount.

DOORS, SASHES AND BLINDS.

The following are Factory prices, and will be found approximately correct for any part of the United States or Canada:

Prices and Sizes of Windows.—Plain Rail Sash.

Eight Lighted Windows.

Size of Glass.	Thickness.	Price per Window.	Price per Window, Glazed.	Size of Window. 1⅛ inch Bar.
Inches.	Inches.	$ cts.	$ cts.	Ft. In. Ft. In.
8 x 12	1 3-16	.36	.95	1 8½ x 4 6
8 x 14	"	.41	1.10	1 8½ x 5 2
8 x 16	"	.48	1.30	1 8½ x 5 10
9 x 12	"	.36	1.05	1 10½ x 4 6
9 x 14	"	.41	1.20	1 10½ x 5 2
9 x 16	"	.48	1.45	1 10½ x 5 10
9 x 18	"	.56	1.60	1 10½ x 6 6
10 x 12	"	.36	1.10	2 0½ x 4 6
10 x 14	"	.41	1.30	2 0½ x 5 2
10 x 16	"	.48	1.55	2 0½ x 5 10
10 x 18	"	.56	1.75	2 0½ x 6 6
10 x 20	"	.64	1.95	2 0½ x 7 2
8 x 12	1 3-8	.43	1.05	1 8½ x 4 6
8 x 14	"	.51	1.20	1 8½ x 5 2
8 x 16	"	.57	1.35	1 8½ x 5 10
9 x 12	"	.43	1.10	1 10½ x 4 6
9 x 14	"	.51	1.30	1 10½ x 5 2
9 x 16	"	.57	1.50	1 10½ x 5 10
9 x 18	"	.63	1.60	1 10½ x 6 6
10 x 12	"	.43	1.20	2 0½ x 4 6
10 x 14	"	.51	1.40	2 0½ x 5 2
10 x 16	"	.57	1.65	2 0½ x 5 10
10 x 18	"	.63	1.80	2 0½ x 6 6
10 x 20	"	.73	2.05	2 0½ x 7 3

Twelve Lighted Windows.

Size of Glass.	Thickness.	Price per Window.	Price per Window, Glazed.	Size of Window.
Inches.	Inches.	$ cts.	$ cts.	Ft. In. Ft. In.
7 x 9	1 3-16	.25	·80	2 1 x 3 4½
8 x 10	"	.25	·90	2 4 x 3 9¼
8 x 12	"	.36	1·20	2 4 x 4 6
8 x 14	"	.40	1.35	2 4 x 5 2
8 x 16	"	.47	1.60	2 4 x 5 10

Twelve Lighted Windows (*Continued*).

Size of Glass.	Thickness.	Price per Window.	Price per Window, Glazed.	Size of Window.			
Inches.	Inches.	$ cts.	$ cts.	Ft.	In.	Ft.	In.
9 x 12	1 3-16	.36	1.30	2	7	x 4	6
9 x 13	"	.40	1.40	2	7	x 4	10
9 x 14	"	.40	1.50	2	7	x 5	2
9 x 15	"	.47	1.65	2	7	x 5	6
9 x 16	"	.47	1.80	2	7	x 5	10
9 x 18	"	.51	1.90	2	7	x 6	6
10 x 12	"	.36	1.40	2	10	x 4	6
10 x 14	"	.40	1.60	2	10	x 5	2
10 x 15	"	.47	1.75	2	10	x 5	6
10 x 16	"	.47	1.95	2	10	x 5	10
10 x 18	"	.51	2.15	2	10	x 6	6
8 x 10	1 3-8	.32	1.00	2	4	x 3	10
8 x 12	"	.45	1.30	2	4	x 4	6
8 x 14	"	.51	1.50	2	4	x 5	2
8 x 16	"	.57	1.60	2	4	x 5	10
9 x 12	"	.45	1.40	2	7	x 4	6
9 x 13	"	.51	1.45	2	7	x 4	10
9 x 14	"	.51	1.65	2	7	x 5	2
9 x 15	"	.57	1.80	2	7	x 5	6
9 x 16	"	.57	1.95	2	7	x 5	10
9 x 18	"	.63	2.05	2	7	x 6	6
10 x 12	"	.45	1.50	2	10	x 4	6
10 x 14	"	.51	1.75	2	10	x 5	2
10 x 15	"	.57	1.90	2	10	x 5	6
10 x 16	"	.57	2.05	2	10	x 5	10
10 x 18	"	.63	2.30	2	10	x 6	6
10 x 20	"	.73	2.60	2	10	x 7	2
10 x 22	"	.83	2.90	2	10	x 7	10
10 x 24	"	.95	3.15	2	10	x 8	6
12 x 14	"	.64	2.15	3	4	x 5	2
12 x 16	"	.70	2.40	3	4	x 5	10
12 x 18	"	.83	2.80	3	4	x 6	6
12 x 20	"	.95	3.15	3	4	x 7	2
12 x 22	"	1.05	3.45	3	4	x 7	10
12 x 24	"	1.20	4.00	3	4	x 8	6

Check Rail or Lip Sash.

Four Lighted Windows.

Size of Glass.	Thickness.	Price per Window.	Price per Window, Glazed and Bedded.	Size of Window. 1⅛ Inch Bar.
Inches.	Inches.	$ cts.	$ cts.	Ft. In. Ft. In.
12 x 20	1 3-8	.46	1.35	2 5 x 3 10
12 x 22	"	.52	1.55	2 5 x 4 2
12 x 24	"	.57	1.65	2 5 x 4 6
12 x 26	"	.64	1.80	2 5 x 4 10
12 x 28	"	.67	1.95	2 5 x 5 2
12 x 30	"	.70	2.10	2 5 x 5 6
12 x 32	"	.75	2.30	2 5 x 5 10
12 x 34	"	.80	2.35	2 5 x 6 2
12 x 36	"	.85	2.50	2 5 x 6 6
12 x 38	"	.90	2.65	2 5 x 6 10
14 x 24	"	.81	2.10	2 9 x 4 6
14 x 26	"	.84	2.20	2 9 x 4 10
14 x 28	"	.87	2.40	2 9 x 5 2
14 x 30	"	.90	2.55	2 9 x 5 6
14 x 32	"	.92	2.65	2 9 x 5 10
14 x 34	"	.95	2.80	2 9 x 6 2
14 x 36	"	.98	2.95	2 9 x 6 6
14 x 38	"	1.00	3.10	2 9 x 6 10
14 x 40	"	1.05	3.30	2 9 x 7 2
16 x 36	"	1.05	3.30	3 1 x 6 6
16 x 38	"	1.10	3.35	3 1 x 6 10
16 x 40	"	1.15	3.75	3 1 x 7 2
16 x 42	"	1.20	3.80	3 1 x 7 6
16 x 44	"	1.25	4.10	3 1 x 7 10
12 x 30	1 3-4	.82	2.40	2 5 x 5 6
12 x 32	"	.85	2.55	2 5 x 5 10
12 x 34	"	.90	2.65	2 5 x 6 2
12 x 36	"	.95	2.80	2 5 x 6 6
12 x 38	"	1.00	2.90	2 5 x 6 10
12 x 40	"	1.05	3.10	2 5 x 7 2
14 x 30	"	1.00	2.80	2 9 x 5 6
14 x 32	"	1.00	2.90	2 9 x 5 10
14 x 34	"	1.05	3.05	2 9 x 6 2
14 x 36	"	1.10	3.25	2 9 x 6 6
14 x 38	"	1.10	3.40	2 9 x 6 10
14 x 40	"	1.15	3.60	2 9 x 7 2
14 x 42	"	1.20	3.80	2 9 x 7 6
14 x 44	"	1.25	3.85	2 9 x 7 10
14 x 46	"	1.30	4.10	2 9 x 8 2
14 x 48	"	1.35	4.50	2 9 x 8 6

Four Lighted Windows (*Continued*).

Size of Glass.	Thickness.	Price per Window.	Price per Window, Glazed and Bedded.	Size of Window. 1⅛ Inch Bar.
Inches.	Inches.	$ cts.	$ cts.	Ft. In. Ft. In.
16 x 36	1 3-4	1.20	3.65	3 1 x 6 6
16 x 38	"	1.25	3.75	3 1 x 6 10
16 x 40	"	1.30	4.05	3 1 x 7 2
16 x 42	"	1.30	4.10	3 1 x 7 6
16 x 44	"	1.35	4.35	3 1 x 7 10
16 x 46	"	1.40	4.90	3 1 x 8 2
16 x 48	"	1.45	5.50	3 1 x 8 6

Segment Face, 1⅜ thick, add 30c.; 1¾ thick, add 40c. Half Circle Face, 1⅜ thick, add 75c.; 1¾ thick, add $1.00. Price same as Common Bar.

Eight Lighted Windows.

Size of Glass.	Thickness.	Price per Window.	Price per Window, Glazed and Bedded.	Size of Window. 1⅛ Inch Bar.
Inches.	Inches.	$ cts.	$ cts.	Ft. In. Ft. In.
9 x 12	1 3-8	.52	1.25	1 11 x 4 6
9 x 14	"	.62	1.50	1 11 x 5 2
9 x 16	"	.66	1.70	1 11 x 5 10
9 x 18	"	.72	1.80	1 11 x 6 6
10 x 12	"	.52	1.30	2 1 x 4 6
10 x 14	"	.62	1.55	2 1 x 5 2
10 x 16	"	.66	1.75	2 1 x 5 10
10 x 18	"	.72	1.95	2 1 x 6 6
10 x 20	"	.85	2.25	2 1 x 7 2
12 x 14	"	.68	1.80	2 5 x 5 2
12 x 16	"	.73	2.00	2 5 x 5 10
12 x 18	"	.85	2.30	2 5 x 6 6
12 x 20	"	.95	2.55	2 5 x 7 2
14 x 16	"	.80	2.30	2 9 x 5 10
14 x 18	"	.95	2.60	2 9 x 6 6
14 x 20	"	1.10	2.90	2 9 x 7 2
14 x 22	"	1.25	3.40	2 9 x 7 10
14 x 24	"	1.45	3.80	2 9 x 8 6
10 x 16	1 3-4	.84	2.10	2 1 x 5 10
10 x 18	"	.88	2.30	2 1 x 6 6
10 x 20	"	.98	2.55	2 1 x 7 2
12 x 14	"	.82	2.15	2 5 x 5 2
12 x 16	"	.88	2.30	2 5 x 5 10
12 x 18	"	.98	2.60	2 5 x 6 6

Eight Lighted Windows (*Continued*).

Size of Glass.	Thickness.	Price per Window.	Price per Window, Glazed and Bedded.	Size of Window. 1⅛ Inch Bar.
Inches	Inches.	$ cts.	$ cts.	Ft. In. Ft. In.
12 x 20	1 3-4	1.10	2.90	2 5 x 7 2
12 x 22	"	1.25	3.20	2 5 x 7 10
12 x 24	"	1.40	3.70	2 5 x 8 6
14 x 16	"	.95	2.60	2 9 x 5 10
14 x 18	"	1.10	2.90	2 9 x 6 6
14 x 20	"	1.25	3.25	2 9 x 7 2
14 x 22	"	1.40	3.75	2 9 x 7 10
14 x 24	"	1.60	4.15	2 9 x 8 6

Segment Face, 1⅜ thick, add 30c.; 1¾ thick, add 40c.
Half Circle Face, 1⅜ thick, add 75c.; 1¾ thick, add $1.00.
Sizes not given above, extra price.

Twelve Lighted Windows.

Size of Glass.	Thickness.	Price per Window.	Price per Window, Glazed and Bedded.	Size of Window
Inches.	Inches.	$ cts.	$ cts.	Ft. In. Ft. In.
8 x 10	1 3-8	.43	1.20	2 4½ x 3 10
8 x 12	"	.54	1.45	2 4½ x 4 6
8 x 14	"	.58	1.60	2 4½ x 5 2
8 x 16	"	.67	1.85	2 4½ x 5 10
9 x 12	"	.54	1.55	2 7½ x 4 6
9 x 13	"	.58	1.70	2 7½ x 4 10
9 x 14	"	.58	1.80	2 7½ x 5 2
9 x 15	"	.58	1.85	2 7½ x 5 6
9 x 16	"	.67	2.10	2 7½ x 5 10
9 x 18	"	.72	2.20	2 7½ x 6 6
10 x 12	"	.54	1.60	2 10½ x 4 6
10 x 14	"	.58	1.85	2 10½ x 5 2
10 x 15	"	.67	2.05	2 10½ x 5 6
10 x 16	"	.67	2.25	2 10½ x 5 10
10 x 18	"	.80	2.60	2 10½ x 6 6
10 x 20	"	.85	2.85	2 10½ x 7 2
10 x 22	"	.92	3.10	2 10½ x 7 10
10 x 24	"	1.00	3.30	2 10½ x 8 6
12 x 14	"	.68	2.30	3 4½ x 5 2
12 x 16	"	.80	2.60	3 4½ x 5 10
12 x 18	"	.93	3.00	3 4½ x 6 6
12 x 20	"	.98	3.25	3 4½ x 7 2

Twelve Lighted Windows (*Continued*).

Size of Glass.	Thickness.	Price per Window.	Price per Window, Glazed and Bedded.	Size of Window.
Inches.	Inches.	$ cts.	$ cts.	Ft. In. Ft. In.
12 x 22	1 3-8	1.05	3.55	3 4½ x 7 10
12 x 24	"	1.10	4.00	3 4½ x 8 6
9 x 12	1 3-4	.69	1.90	2 7½ x 4 6
9 x 13	"	.73	2.00	2 7½ x 4 10
9 x 14	"	.73	2.10	2 7½ x 5 2
9 x 15	"	.78	2.25	2 7½ x 5 6
9 x 16	"	.84	2.50	2 7½ x 5 10
9 x 18	"	.89	2.65	2 7½ x 6 6
10 x 12	"	.70	1.95	2 10½ x 4 6
10 x 14	"	.73	2.25	2 10½ x 5 2
10 x 15	"	.84	2.40	2 10½ x 5 6
10 x 16	"	.84	2.60	2 10½ x 5 10
10 x 18	"	.89	2.85	2 10½ x 6 6
10 x 20	"	1.00	3.15	2 10½ x 7 2
10 x 22	"	1.10	3.45	2 10½ x 7 10
10 x 24	"	1.20	3.70	2 10½ x 8 6
12 x 14	"	.85	2.65	3 4½ x 5 2
12 x 16	"	.89	2.90	3 4½ x 5 10
12 x 18	"	1.00	3.30	3 4½ x 6 6
12 x 20	"	1.20	3.65	3 4½ x 7 2
12 x 22	"	1.30	4.00	3 4½ x 7 10
12 x 24	"	1.35	4.50	3 4½ x 8 6

Transom Sash.

Two Lights.

Size of Glass.	Thickness.	Price.	Price, Glazed.	Size of Window.
Inches	Inches.	$ cts.	$ cts.	Ft. In. In.
8 x 13	1 3-8	.25	.55	2 6 x 12
10 x 13	"	.25	.60	2 6 x 14
12 x 13	"	.25	.65	2 6 x 16
8 x 14	"	.32	.65	2 8 x 12
10 x 14	"	.32	.75	2 8 x 14
12 x 14	"	.32	.75	2 8 x 16
10 x 15	"	.32	.75	2 10 x 14
12 x 15	"	.32	.80	2 10 x 16
14 x 15	"	.32	.95	2 10 x 18
10 x 16	"	.32	.80	3 0 x 14
12 x 16	"	.32	.85	3 0 x 16
14 x 16	"	.32	.95	3 0 x 18
16 x 16	"	.38	1.05	3 0 x 20

Pantry Check Rail or Lip Sash.

Four Lighted Windows, one light wide.

Size of Glass.	Thickness.	Price per Window.	Price per Window, Glazed and Bedded.	Size of Window.
Inches.	Inches.	$ cts.	$ cts.	Ft. In. Ft. In.
9 x 12	1 3-8	.50	1.00	1 1 x 4 6
9 x 14	"	.55	1.25	1 1 x 5 2
9 x 16	"	.60	1.50	1 1 x 5 10

Fifteen and Eighteen Light Windows.

For 15 Light Windows, add to price of 12 Light Windows $\frac{1}{4}$.
" 18 " " " " 12 " " $\frac{1}{2}$.

Segment Transom Sash.

One Light for Double Doors.

Size of Sash.	Thickness.	Price.	Price, Glazed.
Ft. In. In.	Inches.	$ cts.	$ cts.
4 0 x 18	1 3-4	1.10	2.40
4 4 x 20	"	1.25	3.10
4 6 x 18	"	1.30	3.00
4 6 x 20	"	1.35	3.25
4 6 x 24	"	1.40	3.75
5 0 x 22	"	1.50	4.00
5 0 x 24	"	1.60	4.50

Hot Bed Sash.

Made for 6 or 7 inch Glass. Odd sizes extra price.

Size of Sash.	Thickness.	Price, each Sash.	Price, each Sash, Glazed.
Ft. In. Ft. In.	Inches.	$ cts.	$ cts.
3 0 x 6 0	1 3-8	1.00	2.25
3 0 x 6 0	1 3-4	1.30	2.75

Four Light Barn Sash.

Size of Glass.	Thickness.	Price per Sash.	Price, per Sash Glazed.
Inches.	Inches.	$ cts.	$ cts.
8 x 10	1 3-16	.25	.65
9 x 12	"	.30	.75
9 x 14	"	.35	.95
9 x 16	"	.35	1.05

Cellar Sash.

Three Lights.

Size of Glass.	Thick-ness.	Price.	Price, Single Glazed.	Price, Double Glazed.	Size of Sash.
Inches.	Inches.	$ cts.	$ cts.	$ cts.	Ft. In. Ft. In.
7 x 9	1 3-8	.16	.40	.50	2 1 x 1 1
8 x 10	"	.20	.45	.60	2 4 x 1 2
9 x 12	"	.22	.55	.80	2 7 x 1 4
9 x 13	"	.22	.60	.85	2 7 x 1 5
9 x 14	"	.25	.65	.90	2 7 x 1 6
9 x 15	"	.25	.70	1.00	2 7 x 1 7
9 x 16	"	.30	.75	1.10	2 7 x 1 8
10 x 12	"	.25	.60	.85	2 10 x 1 4
10 x 14	"	.25	.70	1.00	2 10 x 1 6
10 x 15	"	.25	.75	1.10	2 10 x 1 7
10 x 16	"	.30	.80	1.15	2 10 x 1 8
12 x 12	"	.25	.70	1.05	3 4 x 1 4
12 x 14	"	.30	.80	1.20	3 4 x 1 6
12 x 16	"	.32	.95	1.40	3 4 x 1 8
12 x 18	"	.35	1.05	1.60	3 4 x 1 10

O. G. Four Panel Doors.

Raised Panels both sides.

Size.	Thickness.	Price, First Quality.	Price, Second Quality.
Ft. In. Ft. In.	Inches.	$ cts.	$ cts.
2 0 x 6 0	1 3-16	1.50	1.30
2 4 x 6 4	"	1.70	1.45
2 0 x 6 6	"	1.70	1.45
2 2 x 6 6	"	1.70	1.45
2 4 x 6 6	"	1.70	1.45
2 6 x 6 6	"	1.70	1.45
2 0 x 6 8	"	1.85	1.60
2 2 x 6 8	"	1.85	1.60
2 4 x 6 8	"	1.85	1.60
2 6 x 6 8	"	1.85	1.60
2 8 x 6 8	"	1.85	1.60
2 0 x 6 10	"	2.00	1.75
2 2 x 6 10	"	2.00	1.75
2 4 x 6 10	"	2.00	1.75
2 6 x 6 10	"	2.00	1.75
2 8 x 6 10	"	2.00	1.75
2 10 x 6 10	"	2.00	1.75

Raised Panels both sides (*Continued*).

Size.				Thickness.	Price, First Quality.	Price, Second Quality.
Ft.	In.	Ft.	In.	Inches.	$ cts.	$ cts.
3	0 x	7	0	1 3-16	2.15	1.90
2	4 x	6	4	1 3-8	1.85	1.50
2	0 x	6	6	"	1.85	1.50
2	2 x	6	6	"	1.85	1.50
2	4 x	6	6	"	1.85	1.50
2	6 x	6	6	"	1.85	1.50
2	0 x	6	8	"	2.00	1.65
2	2 x	6	8	"	2.00	1.65
2	4 x	6	8	"	2.00	1.65
2	6 x	6	8	"	2.00	1.65
2	8 x	6	8	"	2.00	1.65
2	0 x	6	10	"	2.15	1.80
2	2 x	6	10	"	2.15	1.80
2	4 x	6	10	"	2.15	1.80
2	6 x	6	10	"	2.15	1.80
2	8 x	6	10	"	2.15	1.80
2	10 x	6	10	"	2.15	1.80
2	0 x	7	0	"	2.30	2.00
2	2 x	7	0	"	2.30	2.00
2	4 x	7	0	"	2.30	2.00
2	6 x	7	0	"	2.30	2.00
2	8 x	7	0	"	2.30	2.00
2	10 x	7	0	"	2.30	2.00
3	0 x	7	0	"	2.30	2.00
2	4 x	7	6	"	2.50	2.20
2	6 x	7	6	"	2.50	2.20
2	8 x	7	6	"	2.50	2.20
2	10 x	7	6	"	2.50	2.20
3	0 x	7	6	"	2.50	2.20
3	0 x	8	0	"	2.65	2.30
2	8 x	6	8	1 3-4	3.00	2.55
2	10 x	6	10	"	3.40	2.85
2	6 x	7	0	"	3.50	3.00
2	8 x	7	0	"	3.50	3.00
2	10 x	7	0	"	3.50	3.00
3	0 x	7	0	"	3.50	3.00
2	8 x	7	6	"	3.75	3.20
2	10 x	7	6	"	3.75	3.20
3	0 x	7	6	"	3.75	3.20
2	8 x	8	0	"	4.00	3.35
2	10 x	8	0	"	4.00	3.35
3	0 x	8	0	"	4.00	3.35
3	0 x	8	6	"	4.50	3.80
3	0 x	9	0	"	4.75	4.20

The prices on the preceding page are for Wedged-up Doors. Sizes not given, extra price. No deductions for Doors not Wedged.

Sash Doors.

Same price as Four Panel Doors, same size and thickness.

Four Panel Moulded Doors.

Flush or Sunk Moulding.

Size.	Thickness.	Price, Moulded 1 side.	Price, Moulded 2 sides.
Ft. In. Ft. In.	Inches.	$ cts.	$ cts.
2 4 x 6 4	1 3-8	2.80	3.25
2 0 x 6 6	"	2.80	3.25
2 2 x 6 6	"	2.80	3.25
2 4 x 6 6	"	2.80	3.25
2 6 x 6 6	"	2.80	3.25
2 0 x 6 8	"	3.00	3.50
2 2 x 6 8	"	3.00	3.50
2 4 x 6 8	"	3.00	3.50
2 6 x 6 8	"	3.00	3.50
2 8 x 6 8	"	3.00	3.50
2 0 x 6 10	"	3.20	3.70
2 2 x 6 10	"	3.20	3.70
2 4 x 6 10	"	3.20	3.70
2 6 x 6 10	"	3.20	3.70
2 8 x 6 10	"	3.20	3.70
2 10 x 6 10	"	3.20	3.70
2 0 x 7 0	"	3.40	3.90
2 2 x 7 0	"	3.40	3.90
2 4 x 7 0	"	3.40	3.90
2 6 x 7 0	"	3.40	3.90
2 8 x 7 0	"	3.40	3.90
2 10 x 7 0	"	3.40	3.90
3 0 x 7 0	"	3.40	3.90
2 4 x 7 6	"	3.60	4.10
2 6 x 7 6	"	3.60	4.10
2 8 x 7 6	"	3.60	4.10
2 10 x 7 6	"	3.60	4.10
3 0 x 7 6	"	3.60	4.10
3 0 x 8 0	"	3.80	4.30
3 0 x 8 6	"	4.00	4.50
2 8 x 6 8	1 3-4	3.80	4.40
2 10 x 6 10	"	4.20	4.80
2 6 x 7 0	"	4.40	5.00
2 8 x 7 0	"	4.40	5.00
2 10 x 7 0	"	4.40	5.00
3 0 x 7 0	"	4.40	5.00

Flush or Sunk Moulding (*Continued*).

Size.				Thickness.	Price, Moulded 1 side.	Price, Moulded 2 sides.
Ft.	In.	Ft.	In.	Inches.	$ cts.	$ cts.
2	8 x	7	6	1 3-4	4.60	5.20
2	10 x	7	6	"	4.60	5.20
3	0 x	7	6	"	4.60	5.20
2	8 x	8	0	"	4.80	5.40
2	10 x	8	0	"	4.80	5.40
3	0 x	8	0	"	4.80	5.40
3	0 x	8	6	"	5.25	5.85
3	0 x	9	0	"	5.65	6.25

Add to price of Moulded Doors for Circle Top Panels or Segment, $1.00 for each side. Sizes not given above, extra price.

Raised Moulding.

Size.				Thickness.	Price, Moulded 1 side.	Price, Moulded 2 sides.
Ft.	In.	Ft.	In.	Inches.	$ cts.	$ cts.
2	4 x	6	4	1 3-8	3.25	4.25
2	0 x	6	6	"	3.25	4.25
2	2 x	6	6	"	3.25	4.25
2	4 x	6	6	"	3.25	4.25
2	6 x	6	6	"	3.25	4.25
2	0 x	6	8	"	3.50	4.45
2	2 x	6	8	"	3.50	4.45
2	4 x	6	8	"	3.50	4.45
2	6 x	6	8	"	3.50	4.45
2	8 x	6	8	"	3.50	4.45
2	0 x	6	10	"	3.70	4.65
2	2 x	6	10	"	3.70	4.65
2	4 x	6	10	"	3.70	4.65
2	6 x	6	10	"	3.70	4.65
2	8 x	6	10	"	3.70	4.65
2	10 x	6	10	"	3.70	4.65
2	0 x	7	0	"	3.90	4.85
2	2 x	7	0	"	3.90	4.85
2	4 x	7	0	"	3.90	4.85
2	6 x	7	0	"	3.90	4.85
2	8 x	7	0	"	3.90	4.85
2	10 x	7	0	"	3.90	4.85
3	0 x	7	0	"	3.90	4.85
2	4 x	7	6	"	4.10	5.05
2	6 x	7	6	"	4.10	5.05
2	8 x	7	6	"	4.10	5.05
2	10 x	7	6	"	4.10	5.05

Raised Moulding (*Continued*).

Size.	Thickness.	Price, Moulded 1 side.	Price, Moulded 2 sides.
Ft. In. Ft. In.	Inches.	$ cts.	$ cts.
3 0 x 7 6	1 3-8	4.10	5.05
3 0 x 8 0	"	4.30	5.25
3 0 x 8 6	"	4.60	5.55
2 8 x 6 8	1 3-4	4.40	5.60
2 10 x 6 10	"	4.80	6.00
2 6 x 7 0	"	5.00	6.20
2 8 x 7 0	"	5.00	6.20
2 10 x 7 0	"	5.00	6.20
3 0 x 7 0	"	5.00	6.20
2 8 x 7 6	"	5.20	6.40
2 10 x 7 6	"	5.20	6.40
3 0 x 7 6	"	5.20	6.40
2 8 x 8 0	"	5.40	6.60
2 10 x 8 0	"	5.40	6.60
3 0 x 8 0	"	5.40	6.60
3 0 x 8 6	"	5.85	7.05
3 0 x 9 0	"	6.25	7.45

Add to price of Moulded Doors for Circle Top Panels or Segment, $1.00 for each side. Sizes not given above, extra price.

Inch Doors.

Four Panel O G. Raised Panels both sides.

Size.	Price, First Quality.	Price, Second Quality.
Ft. In. Ft. In.	$ cts.	$ cts.
2 0 x 6 0	1.05	.90
2 0 x 6 4	1.05	.90
2 4 x 6 4	1.20	1.05
2 0 x 6 6	1.20	1.05
2 2 x 6 6	1.20	1.05
2 4 x 6 6	1.20	1.05
2 6 x 6 6	1.35	1.15
2 0 x 6 8	1.20	1.05
2 2 x 6 8	1.20	1.05
2 4 x 6 8	1.35	1.15
2 6 x 6 8	1.50	1.30
2 8 x 6 8	1.50	1.30

Inch Doors are made out ot inch lumber, and finish up full ⅞ inch thick.
These prices a e for Wedged-up Doors.
No deductions made for Doors not Wedged.

Store Doors.

Heavy Raised Mouldings Outside.

Size.	Thickness.	With Sash Rabatted on for Shutters.	With Shutters fitted and trimmed.
Inches.	Inches.	$ cts.	$ cts.
4 6 x 7 0	1 3-8	7.20	10.40
5 0 x 7 0	"	8.00	11.20
5 0 x 7 6	"	8.80	12.00
5 0 x 8 0	"	9.60	12.80
5 0 x 7 0	1 3-4	8.80	12.00
5 0 x 7 6	"	9.60	12.80
5 0 x 8 0	"	10.40	13.60
5 0 x 8 6	"	11.20	14.40
5 0 x 9 0	"	12.00	15.20
6 0 x 9 0	"	12.80	16.00

Double thick, add 50 to 100 per cent. All heavy raised, moulded on one side.

Double Front Doors.

Heavy Raised Moulding Outside, Circle Top Panels.

Size.	Thickness.	Price per pair.
Ft. In. Ft. In.	Inches.	$ cts.
4 0 x 7 0	1 3-4	12.00
4 4 x 7 0	"	12.00
4 6 x 7 0	"	12.80
4 6 x 7 6	"	13.60
4 6 x 8 0	"	14.40
5 0 x 7 6	"	14.40
5 0 x 8 0	"	15.20

Outside Blinds.

Twelve Light Windows.

Size.	Thickness.	Price, Rolling Slats.	Stationary Slats.
Inches.	Inches.	$ cts	
8 x 10	1 3-16	1.00	Same price as Rolling Slats.
8 x 12	"	1.25	
8 x 14	"	1.40	
9 x 12	"	1.25	
9 x 13	"	1.40	
9 x 14	"	1.40	
9 x 15	"	1.50	

Twelve Light Windows (*Continued*).

Size.	Thickness.	Price, Rolling Slats.	Stationary Slats.
Inches.	Inches.	$ cts.	
9 x 16	1 3-16	1.50	Same price as Rolling Slats.
9 x 18	"	1.70	
10 x 12	"	1.25	
10 x 14	"	1.40	
10 x 15	"	1.50	
10 x 16	"	1.50	
10 x 18	"	1.70	
10 x 20	"	1.60	

Eight Light Windows.

Size.	Thickness.	Price, Rolling Slats.	Stationary Slats
Inches.	Inches.	$ cts.	
9 x 12	1 3-16	1.25	Same price as Rolling Slats.
9 x 14	"	1.40	
9 x 16	"	1.50	
9 x 18	"	1.70	
10 x 12	"	1.25	
10 x 14	"	1.40	
10 x 16	"	1.50	
10 x 18	"	1.70	
10 x 20	"	1.90	
12 x 14	"	1.40	
12 x 16	"	1.50	
12 x 18	"	1.70	
12 x 20	"	1.90	

Four Light Windows.

Size.	Thickness.	Price, Rolling Slats.	Stationary. Slats.
Inches.	Inches.	$ cts.	
12 x 20	1 3-16	1.00	Same price as Rolling Slats.
12 x 22	"	1.25	
12 x 24	"	1.25	
12 x 26	"	1.40	
12 x 28	"	1.40	
12 x 30	"	1.50	
12 x 32	"	1.50	

Four Light Windows (*Continued*).

Size.	Thickness.	Price, Rollling Slats.	Stationary Slats.
Inches.	Inches.	$ cts.	
12 x 34	1 3-16	1.70	Same price as Rolling Slats.
12 x 36	"	1.70	
12 x 38	"	1.90	

1⅜ thick, add to price of 1 3-16, per window, 25c. Segment Head Blinds, add 35 to 40 cents. Half Circular Head Blinds, add 75c. to $1.00.

Size of Blinds measure same as Check Rail Window, with the addition of one inch to the bottom Rail, for Sub sill Window Frames.

Inside Blinds.

O G Panel or Rolling Slats, four fold, measuring height of window, ordinary width, per foot............................70 cents.
Thickness, 1⅛ inch.

The above prices are for Pine. If hard wood, such as Cherry, Ash, Maple or Black Walnut, charge about double the price of Pine.

Window Frames for Wood Buildings.

For Plain Rail Sash, with Outside Casings.

Size.	Price.	Size.	Price.
Inches.	$ cts.	Inches.	$ cts.
8 x 10	1.00	9 x 15	1.80
9 x 12	1.35	9 x 16	1.80
10 x 12	1.35	10 x 15	2.00
9 x 14	1.65	10 x 16	2.00
10 x 14	1.65		

Frames for Check Rail Sash, with Outside Casings.

Size.	Price.	Size.	Price.
Inches.	$ cts.	Inches.	$ cts.
8 x 10	1.65	10 x 15	2.20
9 x 12	1.80	9 x 16	2.20
10 x 12	1.80	10 x 16	2.20
9 x 14	2.00	9 x 18	2.40
10 x 14	2.00	10 x 18	2.40
9 x 15	2.00	10 x 20	2.40

Frames with Pulleys for Weights, add 60c. Frames with Mouldings, add 60c. Segment Frames, add 35c.

Plain Door Frames for Frame Buildings.

Size.		Price.
2 ft. 6 x 6 ft. 6 2 ft. 8 x 6 ft. 8	Outside Frames, Casing 1 side..............	$2.50
2 ft. 6 x 6 ft. 6 2 ft. 8 x 6 ft. 8	Inside " " 2 sides.............	2.25

Window Frames for Brick Buildings.

Plain Window Frames.

Made for either Plain or Check Rail, same price.

Size.	Price.	Size.	Price.
Inches.	$ cts.	Inches.	$ cts.
8 x 10	2.00	10 x 16	2.65
9 x 12	2.10	9 x 18	3.00
10 x 12	2.10	10 x 18	3.00
9 x 14	2.35	10 x 20	3.25
10 x 14	2.35	10 x 22	3.50
9 x 15	2.35	10 x 24	3.50
10 x 15	2.65	12 x 22	3.50
9 x 16	2.65	12 x 24	3.50

Box Window Frames.

Size.	Price.	Size.	Price.
Inches.	$ cts.	Inches.	$ cts.
8 x 10	2.65	10 x 16	3.25
9 x 12	2.80	9 x 18	3.25
10 x 12	2.80	10 x 18	3.25
9 x 14	3.00	10 x 20	3.65
10 x 14	3.00	12 x 20	4.00
9 x 15	3.25	12 x 22	4.00
10 x 15	3.25	12 x 24	4.00
9 x 16	3.25		

Segment outside, Square inside, add 40 cts.

Roped, Ribbon, Spiral and Beaded Mouldings.

Price List—Net Prices.

*PINE OR WHITE WOOD.

	per ft. (lineal).		per ft. (lineal).
3/8, 1/2 and 5/8 inch.............	5c	2 1/2 inch....................	15c
1 inch....................	6c	3 "	18c
1 1/4 "	7c	3 1/2 "	25c
1 1/2 "	8c	4 "	30c
2 "	10c	5 "	40c

*WALNUT OR HARD WOOD.

Size	per ft. (lineal).	Size	per ft. (lineal).
$\frac{3}{8}$, $\frac{1}{2}$ and $\frac{5}{8}$ inch	8c	$2\frac{1}{2}$ inch	25c
1 inch	10c	3 "	30c
$1\frac{1}{4}$ "	12c	$3\frac{1}{2}$ "	35c
$1\frac{1}{2}$ "	14c	4 "	45c
2 "	18c	5 "	60c

*Circles from three to four times the price of straight; cut right and left. Prices not subject to regular discount.

Approximate Weights.

Weight of Doors.

	1 3-16	1 3-8
4 panel, 2-6 x 6-6	32 lbs.	35 lbs.
4 " 2-8 x 6-8	34 "	38 "
4 " 2-10 x 6-10	36 "	42 "
4 " 3 x 7	38 "	48 "

Add 12 lbs. for 1¾ thick, to weight of 1⅜ inch.
4 panel 2-6 x 6-6, inch. 26 lbs.

Weight of 8 Light Windows.

Size.	Thick-ness.	Glazed.	Un-glazed.
9 x 12	1 3-8	17 lbs.	8 lbs.
10 x 14	"	19 "	11 "
10 x 16	"	22 "	12 "
12 x 14	"	23 "	11 "
12 x 16	"	24 "	12 "
12 x 18	"	27 "	13 "
12 x 20	"	32 "	14 "

Weight of Blinds.

8 x 10	1 3-16	14 lbs.
9 x 12	"	17 "
10 x 14	"	20 "
10 x 16	"	22 "
10 x 18	"	24 "
10 x 20	"	27 "

Weight of 12 Light Windows.

Size.	Thick-ness.	Glazed.	Un-glazed.
8 x 10	1 3-16	14 lbs.	6 lbs.
9 x 12	"	18 "	8 "
9 x 12	1 3-8	21 "	9 "
10 x 14	"	26 "	11 "
10 x 16	"	27 "	12 "
10 x 18	"	33 "	13 "

Weight of Mouldings.

1 inch x 1 inch, 108 feet lineal, 15 lbs.

Weight of Lumber, etc., Dry.

Flooring, Dressed and Matched,	per 1,000 feet	1,800	pounds.
Siding, Dressed,	" "	800	"
Ceiling, $\frac{3}{8}$ inch thick,	" "	800	"
" $\frac{1}{2}$ "	" "	900	"
Boards, Dressed 1 side,	" "	2,100	"
" and Dimension, Rough,	" "	2,500	"
Shingles,	" "	275	"
Lath,	" pieces	500	"
Pickets, Dressed,	" "	1,800	"
" Rough,	" "	2,500	"

	Approximate Price.	Correct Price.
STAIRCASES.		
Stair builders generally furnish their prices at so much per step, including rails, balusters, newels, etc., all complete and fixed in accordance with plans and specification furnished to them by Architects.		
The following are approximate prices:		
Plain staircases of pine, 3 feet wide, with returned nosings and scroll brackets, hard wood rail, turned newel and balusters.........at per step	3.50	
It is found impossible, however, to give in a work of this kind prices for the various kinds of carpenter's work, which vary in dimensions, material and finish; enough information, however, it is hoped, has been furnished to be of service in making out approximate estimates.		
Fancy Turned Balusters.		
Prices for Fancy Turned Cherry or Black Walnut Balusters:		
1½ inch balusters..........................	0.08	
1¾ " "	0.10	
2 " "	0.12	
2¼ " "	0.14	
2½ " "	0.16	
With neck moulding, add 2 cents each.		
Prices for Oak or Ash Balusters:		
1½ inch balusters	0 06	
1¾ " "	0.08	
2 " "	0.10	
2¼ " "	0.12	
2½ " "	0.14	
Fancy Turned Newel Posts.		
Prices for Black Walnut or Cherry:		
5 inch newel posts, with cap, each..............	2.00	
6 " " " " "	2.50	
7 " " " " " walnut only...	3.25	
8 " " " " " " " ...	4.00	
Fluted or Octagon Balusters.		
Prices for Fluted or Octagon Cherry or Black Walnut Balusters:		
1¾ inch fluted or octagon..................each	0.16	
2 " " " .... "	0.18	
2¼ " " " .... "	0.20	

	Approximate Price.	Correct Price.
2½ inch fluted or octagon..................each	0.22	
2¾ " " " .... "	0.24	
Mahogany costs about double price.		
Prices for Oak or Ash Balusters:		
1¾ inch fluted or octagon,... ....each	0.14	
2 " " " .... "	0.16	
2¼ " " " .... "	0.18	
2½ " " " .... "	0.20	
2¾ " " " .... "	0.22	
Plain Octagon Staved Newel Posts.		
Prices for Plain Octagon Staved Newel Posts, Black Walnut, Cherry, Oak or Ash.		
8 inch octagon newel posts, with cap...........	5.00	
9 " " " " "	5.25	
10 " " " " "	5.50	
11 " " " " "	5.75	
12 " " " " "	6.00	
For mahogany posts, add $3.00 each; for raised O G panel, add $1.25 each.		
Octagon Sunk Panel Newel Posts.		
Prices for Sunk Panel Newel Posts, Fancy Moulded, Black Walnut, Cherry or Oak:		
8 inch sunk panel posts, with cap.............	8.00	
9 " " " " "	8.50	
10 " " " " "	9.00	
11 " " " " "	9.50	
12 " " " " "	10.00	
For circle top panel........................add	1.00	
" mahogany......................... ... "	2.00	
" circle top panel....................... "	1.25	
" full veneered.......................... "	4.00	
Sunk Panel Newel Posts, Panels Veneered.		
Prices for Sunk Panel Newel Posts, Black Walnut, Cherry or Oak, with Panels Fancy Moulded, and Veneered with Mahogany, Rosewood or Bird's-eye Maple:		
8 inch posts, with cap........................	8.50	
9 " " "	9.00	
10 " " "	9.50	
11 " " "	10.00	
12 " " "	10.50	
Full veneered...............................add	2.50	
" " with French burl.............. "	3.50	
" " " " extra......... "	4.00	
" " " " double extra... "	1.50	

Note.—The above are wholesale factory prices; add profits.

TABLE FOR DETERMINING THE NUMBER OF

Risers.										
1	0.6″	0. 6¼″	0. 6½″	0. 6¾″	0. 7″	0. 7⅛″	0. 7¼′	0. 7⅜″	0. 7½″	0. 7⅝″
2	1.0	1. 0½	1. 1	1. 1½	1. 2	1. 2¼	1. 2½	1. 2¾	1. 3	1. 3¼
3	1.6	1. 6¾	1. 7½	1. 8¼	1. 9	1. 9⅜	1. 9¾	1.10⅛	1.10½	1.10⅞
4	2.0	2. 1	2. 2	2. 3	2. 4	2. 4½	2. 5	2. 5½	2. 6	2. 6½
5	2.6	2. 7¼	2. 8½	2. 9¾	2.11	2.11⅝	3. 0¼	3. 0⅞	3. 1½	3. 2⅛
6	3.0	3. 1½	3. 3	3. 4½	3. 6	3. 6¾	3. 7½	3. 8¼	3. 9	3. 9¾
7	3.6	3 7¾	3. 9½	3.11½	4. 1	4. 1⅞	4. 2¾	4. 3⅝	4. 4½	4. 5⅜
8	4 0	4. 2	4. 4	4. 6	4. 8	4. 9	4.10	4.11	5. 0	5. 1
9	4.6	4. 8¼	4.10½	5. 0¾	5. 3	5. 4⅛	5. 5¼	5. 6⅜	5. 7½	5. 8⅝
10	5 0	5. 2½	5. 5	5. 7½	5.10	5.11¼	6. 0½	6. 1¾	6. 3	6. 4¼
11	5.6	5. 8¾	5.11½	6. 2¼	6. 5	6. 6⅜	6. 7¾	9. 9⅛	6.10½	6.11⅞
12	6.0	6. 3	6. 6	6. 9	7. 0	7. 1½	7. 3	7. 4½	7 6	7. 7½
13	6 6	6. 9¼	7. 0½	7. 3¾	7. 7	7. 8⅝	7.10¼	7.11⅞	8. 1½	8. 3⅛
14	7.0	7. 3½	7. 7	7.10½	8. 2	8. 8¾	8. 5½	8. 7¼	8. 9	8.10¾
15	7.6	7. 9¾	8. 1½	8. 5¼	8. 9	8.10⅞	9. 0¾	9. 2⅝	9. 4½	9. 6⅜
16	8.0	8. 4	8. 8	9. 0	9. 4	9. 6	9. 8	9.10	10. 0	10. 2
17	8.6	8.10¼	9. 2½	9. 6¾	9.11	10. 1⅛	10. 3¼	10. 5⅜	10. 7½	10. 9⅝
18	9.0	9. 4½	9. 9	10. 1½	10. 6	10. 8¼	10.10½	11. 0¾	11. 3	11. 5¼
19	9.6	9.10¾	10. 3½	10. 8¼	11. 1	11. 3⅜	11. 5¾	11. 8⅛	11.10½	12. 0⅞
20	10.0	10. 5	10.10	11. 3	11. 8	11.10½	12. 1	12. 3½	12. 6	12 8½
21	10.6	10.11¼	11. 4½	11. 9¾	12. 3	12. 5⅝	12. 8¼	12.10⅜	13. 1½	13. 4⅛
22	11.0	11. 5½	11.11	12. 4½	12.10	13. 0¾	13. 3½	13. 6¼	13. 9	13.11¾
23	11.6	11 11¾	12. 5½	12.11¼	13. 5	13. 7⅞	13.10¾	14. 1⅝	14. 4½	14. 7⅜
24	12.0	12. 6	13. 0	13. 6	14. 0	14. 3	14. 6	14. 9	15. 0	15. 3
25	12.6	13. 0¼	13. 6½	14. 0¾	14. 7	14.10⅛	15. 1¼	15. 4⅜	15. 7½	15.11⅝
26	13.0	13. 6½	14. 1	14. 7½	15. 2	15. 5¼	15. 8½	15.11¾	16. 3	16. 6¼
27	13.6	14. 0¾	14. 7½	15. 2¼	15. 9	16. 0⅜	16. 3¾	16. 7⅛	16.10½	17. 1⅞
28	14.0	14. 7	15. 2	15. 9	16. 4	16. 7½	16.11	17. 2½	17. 6	17. 9½
29	14.6	15. 1¼	15. 8½	16. 3¾	16.11	16. 2⅝	17. 6¼	17. 9⅞	18. 1½	18. 5⅛
30	15.0	15. 7½	16. 3	16.10½	17. 6	17. 9¾	18. 1½	18. 5¼	18. 9	19. 0¾

EXPLANATION.—In column, beginning with rise of step column of Risers, will be the No. In column of Treads, the column beginning with width of tread desired, will be the

TREADS AND RISERS FOR GIVEN HEIGHTS AND RUNS.

												Treads
0. 7¾"	0. 7⅞"	0.8"	0. 8¼"	0. 8½"	0.9'	0. 9½"	0.10"	0.10½"	0.11"	0.13"	0.14"	**1**
1. 3½	1. 3¾	1.4	1. 4½	1. 5	1.6	1. 7	1. 8	1. 9	1 10	2. 2	2. 4	**2**
1.11¼	1.11⅝	2.0	2. 0¾	2. 1½	2.3	2. 4½	2. 6	2. 7½	2. 9	3. 3	3. 6	**3**
2. 7	2. 7½	2.8	2. 9	2.10	3.0	3. 2	3. 4	3. 6	3. 8	4. 4	4. 8	**4**
3. 2¾	3. 3⅜	3.4	3. 5¼	3. 6½	3.9	3.11½	4. 2	4. 4½	4. 7	5. 5	5.10	**5**
3.10½	3.11¼	4.0	4. 1½	4. 3	4.6	4. 9	5. 0	5. 3	5. 6	6. 6	7. 0	**6**
4. 6¼	4. 7⅛	4.8	4. 9¾	4.11½	5.3	5. 6½	5.10	6. 1½	6. 5	7. 7	8. 2	**7**
5. 2	5. 3	5.4	5. 6	5. 8	6.0	6. 4	6. 8	7. 0	7. 4	8. 8	9. 4	**8**
5. 9¾	5.10⅞	6.0	6. 2¼	6. 4½	6.9	7. 1½	7. 6	7.10½	8. 3	9. 9	10. 6	**9**
6. 5½	6. 6¾	6.8	6.10½	7. 1	7.6	7.11	8. 4	8. 9	9 2	10.10	11. 8	**10**
7. 1¼	7. 2⅝	7.4	7. 6¾	7. 9½	8.3	8. 8½	9. 2	9. 7½	10. 1	11.11	12.10	**11**
7. 9	7.10½	8.0	8. 3	8. 6	9.0	9. 6	10. 0	10. 6	11. 0	13. 0	14. 0	**12**
8. 4¾	8. 6⅜	8.8	8.11¼	9. 2½	9.9	10. 3½	10.10	11. 4½	11.11	14. 1	15. 2	**13**
9. 0½	9. 2¼	9.4	9. 7½	9.11	10.6	11. 1	11. 8	12. 3	12.10	15. 2	16. 4	**14**
9. 8¼	9.10⅛	10.0	10. 3¾	10. 7½	11.3	11.10½	12. 6	13. 1½	13. 9	16. 3	17. 6	**15**
10. 4	10. 6	10.8	11. 0	11. 4	12.0	12. 8	13. 4	14. 0	14. 8	17. 4	18. 8	**16**
10.11¾	11. 1⅞	11.4	11. 8¼	12. 0½	12.9	13. 5½	14. 2	14.10½	15. 7	18. 5	19.10	**17**
11. 7½	11. 9¾	12.0	12. 4½	12. 9	13.6	14. 3	15. 0	15. 9	16. 6	19. 6	21. 0	**18**
12. 3¼	12. 5⅝	12.8	13. 0¾	13. 5½	14.3	15. 0½	15 10	16. 7½	17. 5	20. 7	22. 2	**19**
12.11	13. 1½	13.4	13. 9	14. 2	15.0	15.10	16. 8	17. 6	18. 4	21. 8	23. 4	**20**
13. 6¾	13. 9⅝	14.0	14. 5¼	14.10½	15.9	16. 7½	17. 6	18. 4½	19. 3	22. 9	24. 6	**21**
14. 2½	14. 5¼	14.8	15. 1½	15. 7	16.6	17. 5	18. 4	19. 3	20. 2	23.10	25. 8	**22**
14.10¼	15. 1⅛	15.4	15. 9¾	16. 3½	17.3	18. 2½	19. 2	20. 1½	21. 1	24.11	26.10	**23**
15. 6	15. 9	16.0	16. 6	17. 0	18.0	19. 0	20. 0	21. 0	22. 0	26. 0	28. 0	**24**
16. 1¾	16. 4⅞	16.8	17. 2¼	17. 8½	18.9	19. 9½	20.10	21.10½	22.11	27. 1	29. 2	**25**
16. 9½	17. 0¾	17.4	17.10½	18. 5	19.6	20. 7	21. 8	22. 9	23.10	28. 2	30. 4	**26**
17. 5¼	17. 8⅝	18.0	18. 6¾	19. 1½	20.3	21. 4½	22. 6	23. 7½	24. 9	29. 3	31. 6	**27**
18. 1	18. 4½	18.8	19. 3	19 10	21.0	22. 2	23. 4	24. 6	25. 8	30. 4	32. 8	**28**
18. 8¾	19. 0⅜	19.4	19.11½	20. 6½	21 9	22.11½	24. 2	25. 4½	26. 7	31. 5	33.10	**29**
19 4½	19 8¼	20.0	20. 7½	21. 3	22 6	23. 9	25 0	26. 3	27. 6	32. 6	35. 0	**30**

desired, find height of story, top to top. On a line with this, in No. is one less than the No. of Risers. On a line with this, in length of run.

	Approximate Price	Correct Price
Nails, per keg.		
Common fence and sheathing nails..............	2.30	
8d and 9d......	2.45	
6d and 7d, common..........................	2.70	
4d and 5d, common..........................	2.95	
3d. and 4d., light.........................	3.70	
3d., fine..................................	4.45	
2d...	4.45	
Cut spike, all sizes.....................	2.30	
Floor casing and box 75c. above the same sizes of common.		
Finishing, $1 above, and fine finishing $1.25 above.		
Clinch Nails, per keg.		
$1\frac{3}{4}$ inch to $1\frac{1}{2}$ inch............................	5.00	
2 " $2\frac{1}{4}$ "	4.50	
$2\frac{1}{2}$ " $2\frac{3}{4}$ "	4.25	
3 inch and longer............	4.00	
Door Butts.		
Size, 4^2 x 4^2 - 5 x 5.		
Japanned acorn..................per doz. pairs	4.15	
Plain bronzed iron.....................per pair	1.00	
Ornamental bronzed iron............... "	1.38	
Ornamental bronzed metal.............. "	2.75	
Sash Weights................. ....per lb.	0.1½	
Sash Line.		
Best Hemp............................per lb.	0.30	
Best linen. .... "	0.62	
Silver Lake........................... "	0.65	
Mortise Locks—brass face and bolt, easy spring.		
$3\frac{1}{2}$ to $4\frac{1}{2}$ inch..........................per doz.	20.00	
Do., for front doors.		
Factory make, plain front..................each	2.50	
Factory make, bronze front................. "	4.50	
Boston make, plain front................... "	8.00	
Door Knobs.		
Solid glass............................per set	0.50	
Silvered glass......................... "	1.00	
Cut glass.............................. "	3.00	
Nickel plated.......................... "	2.00	
Bronze metal........................... "	3.00	
Sash fasts.		
Plain brass......................... .per doz.	2.50	
Plain brass, self-locking................ "	7.50	

	Approximate Price.	Correct Price.
Nickel plated, self-locking.................per doz.	4.50	
Bronze metal, self-locking............... "	12.00	
Screws.		
Round head, nickel plated, for window beads......................per gross { 1¼ in.	1.25	
1½ "	1.50	
Store Door Handles—with mortise latch.		
Lacquered brass........................per set	3.50	
Bronze metal.......................... "	7.00	
Lead.		
Lead pipe.............................per lb.	0.7½	
Sheet lead............................ "	0.08	
Block tin pipe........................ "	0.35	
Iron.		
Wrought iron I beams, 4 to 10½ in........per lb.	0.04	
Wrought iron I beams, 12 in.............. "	0.04	
Wrought iron I beams, 15 in.............. "	0.04	
Wrought iron channel beams, 4 to 12 in.... "		
Wrought angle iron...................... "	0.3½	
Wrought T iron.......................... "	0.04	
Wrought girder plates................... "	0.04	
Wrought girder rivets................... "	0.05	
Hyatt light...........................per ft.	4.00	
Sheet Iron.		
Common....................................	0.5½	
Russia iron...............................	0.13	
American planished A......................	0.10½	
" " B......................	0.9½	
Galvanized iron...........................	0.13	
Copper.		
Sheathing copper..........................	0.28	
Sheet Zinc.		
Full casks................................	0.08	
Loose.....................................	0.8½	

PAINTING AND GLAZING.

	Approximate Price.	Correct Price.
Including labor and materials of the best quality, and finding all ladders, scaffolding, and other appliances necessary for carrying on the work.		

PAINTING AND GLAZING (*Continued*).		Approximate Price.	Correct Price.
Per Yard Superficial.			
Painting on flat surfaces any common color	1 coat	0.08	
	2 "	0.12½	
	3 "	0.17	
	4 "	0.20	
Add for extra colors, to be added to the price of common colors.			
Drabs, French gray, salmon, fawn, 3 cts.; Brunswick green, 4 cts.; peach blossom and lilac, 12 cts.; patent greens, yellow and blue verditer, 15 cts.; Chinese vermilion or lake, 50 cts.; Chinese or lake, twice done on a scarlet ground, 75 cts.			
Flatted work also charged extra.			
Painting common color on sashes, for each side..........	1 coat	0.10	
	2 "	0.14	
do. do. cornices, facias and soffits of projecting roofs, or similar work	3 "	0.18	
	4 "	0.20	
do. do. common color in iron railings, gates, etc., with plain or spiked tops, including details, measured net..........	1 "	0.11	
	2 "	0.16	
	3 "	0.20	
	4 "	0.22	
do. do. common color, on window guards or other wire work, both sides..........	1 "	0.16	
	2 "	0.20	
Painting common color, on jalousie or Venetian shutters, including frames, measured from out to out, without measuring laths..........	1 "	0.16	
	2 "	0.19	
	3 "	0.24	
	4 "	0.27	
do in green, do. do. do.	1 "	0.16	
	2 "	0.20	
	3 "	0.23	
	4 "	0.28	
do. in common colors, on sash frames	1 "	0.09	
	2 "	0.12	
	3 "	0.15	
	4 "	0.18	
LINEAL WORK.			
In common colors, except where expressed otherwise.			
Per Lineal Yard.			
Bars, iron or other kind, plain work....	1 coat	0.03	
	2 "	0.04	

PAINTING AND GLAZING (*Continued*).		Approximate Price.	Correct Price.
Chains, any medium size	1 coat	0.04	
	2 "	0.05	
Chain rail or surbase, handrails or pin-rails, exclusive of pin, or bands	1 "	0.04	
	2 "	0.05	
	3 "	0.06	
Eave gutters and rain water conductors, including heads, shoes, brackets, bands and holdfasts	2 "	0.08	
	3 "	0.10	
	4 "	0.12	
Gas or iron water pipes	2 "	0.04	
Mouldings under 3 inches girth, where detached from painted work, or when painted a different color	2 "	0.03	
	3 "	0.04	
	4 "	0.05	
Ladders, including rungs	2 "	0.10	
Skirtings, square or moulded, under 9 inches wide	2 "	0.07	
	3 "	0.09	
Hand rails, plain or moulded	2 "	0.09	
String course, or edge of coping	2 "	0.08	
	3 "	0.10	
Reveals of doors or windows — 4½ inches wide	2 "	0.05	
Reveals of doors or windows — 9 " "	2 "	0.07	
Letters or figures, black or white, painted in oil	per inch	0.03½	
NUMERICAL WORK.			
Balusters, wood or iron ....per doz.	2 coats	0.36	
Brackets or cantilevers, wood or iron, each,	2 "	0.07	
Chimney pots, iron or other........ do.	2 "	0.24	
Chimney pieces of any plain kind, each	2 "	0.25	
	3 "	0.30	
Door scrapers or knockers......... do.	2 "	0.08	
Hinges, hook and eye strap, and similar work under 12 inches in length...each	2 "	0.05	
Hinges, hook and eye strap, and similar work, above 12 inches in length..each	2 "	0.08	
Hooks, pins, staples, knobs, buttons, bolts, nuts, holdfasts, butt hinges, or similar work...............per dozen	2 "	0.10	
Lamps, street—mineral green........each	2 "	0.25	
do. bronzed............. do.	2 "	0.40	
Lamp irons...................... do.	2 "	0.12	
Lamp-posts, including lamp frames, heel posts, saddle, brackets and other fitments..........................each	2 "	0.40	
Locks of any kind, including staples, etc...........................each	2 "	0.05	

PAINTING AND GLAZING (*Continued*).		Approximate Price.	Correct Price.
Mangers of any kind, including rings and bolts.....each	2 coats	0.20	
Newels, plain.....each	1 coat	0.10	
Running bolts, any size above 12 inches in length, including hasps and staples.....each	2 "	0.10	
Stay bars to chimney shafts, or similar work.....each	2 "	0.30	
Ventilators, including frames for each side, painted.....each	2 "	0.04	
Gratings, do. do. do.	2 "	0.05	
Window sills..... do.	2 " 3 "	0.60	
REPAIRS TO OLD WORK, ETC.			
Painting in common colors in repairs to patches, not exceeding one foot superficial.....each	1 " 2 "	0.05 0.07	
Painting in common colors in repairs to patches, exceeding one foot, and not exceeding half a yard superficial, each	1 " 2 "	0.15 0.18	
Painting in common colors in repairs to patches, exceeding half a yard, and not exceeding six yards superficial...each	1 " 2 "	0.15 0.18	
Add 25 per cent to the above if in superior colors.			
MISCELLANEOUS WORK.			
Per Yard Superficial.			
Painting with mineral or anti-corrosive paint.....	1 coat 2 "	0.08 0.10	
do. with fire-proof paint.....	1 " 2 "	0.06 0.10	
do. or paying over with best vegetable tar mixed with ochre or Spanish brown and pitch in such proportions as may be directed, and thoroughly mixed and boiled together	1 "	0.10	
do. with coal tar, mixed with 1 lb. pitch, and 1 lb. rosin to 6 gallons coal tar, boiled together.....	1 "	0.05	
Sanding in imitation of stone, or splashed in imitation of granite, add to common painting..		0.10	

PAINTING AND GLAZING (*Continued*).		Approximate Price.	Correct Price.
GRAINING AND VARNISHING.			
Per Yard Superficial.			
Common graining, in oil or water colors, as may be ordered, in imitation of oak, maple, rosewood, walnut, or mahogany, including glazing		0.12	
Superior do. do. do.		0.22	
Per Foot Lineal.			
Graining, in imitation of any wood on hand rails or similar work..............................		0.08	
NUMERICAL WORK.			
Graining in imitation of any wood on plain newels or similar work...................each		0.15	
Graining in imitation of any wood on balusters, plain or turned, or similar work..........each		0.04	
VARNISHING.			
Per Yard Superficial.			
Varnishing with best copal on new or old painted, or grain work...........	1 coat	0.08	
	2 "	0.15	
Varnishing on hard wood, including sandpapering and oiling.............	1 "	0.10	
	2 "	0.18	
Per Foot Lineal.			
Varnishing with best copal on hand-rails or similar work......................	1 "	0.05	
	2 "	0.10	
NUMERICAL WORK.			
Varnishing with best copal on newels, plain or turned, or similar work......	1 "	0.20	
	2 "	0.30	
Varnishing with best copal on balusters, plain or turned, or similar work.....	1 "	0.06	
	2 "	0.08	
Glazier's work varies in prices so much that it is considered best not to quote any price. As a general rule, the painter takes the contract to perform all the work in this department, along with the painting, but it is much better to let the contract of glazing and furnishing glass, independently, and prices for the work can be obtained in any locality from resident painters.			

Window Glass, Prices Current per box of 5 feet.

Single.

Sizes.	1st.	2d.	3d.	4th.
6 x 8—10 x 15.....	$8.00	$6.75	$6.25	$5.00
11 x 14—16 x 24.....	8.75	0.00	7.50	7.00
11 x 22—20 x 30.....	11.25	10.50	9.75	8.00
15 x 36—24 x 30.....	12.75	11.50	10.00	
26 x 28—24 x 36....	13.50	12.25	11.25	
26 x 36—26 x 44.....	14.75	13.75	11.75	
26 x 46—30 x 50.....	16.25	15.00	13.00	
30 x 52—30 x 54.....	17.25	16.00	13.50	
30 x 56—34 x 56.....	18.75	16.75	15.00	
34 x 58—34 x 60.....	19.50	18.00	16.00	
36 x 60—40 x 60.....	21.00	19.50	18.00	

Double.

Sizes.	1st.	2d.	3d.	4th.
6 x 8—10 x 15.....	$12.00	$11.00	$10.00	$ 9.25
11 x 14—16 x 24.....	14.75	13.75	12.75	11.75
18 x 22—20 x 30....	19.00	17.75	16.00	
15 x 36—24 x 30.....	21.50	19.25	16.50	
16 x 28—24 x 36.....	23.00	20.75	18.25	
26 x 36—26 x 44.....	25.00	23.00	19.25	
26 x 46—30 x 50.....	27.00	25.00	21.25	
30 x 52—30 x 54.....	28.50	26.00	22.25	
30 x 56—34 x 56.....	30.00	27.75	24.75	
32 x 58—34 x 60.....	31.75	30.00	27.00	
34 x 60—40 x 60....	35.50	32.50	30.25	

Sizes above—$10 per box extra for every five inches.

An additional 10 per cent. will be charged for all glass more than 40 inches wide. All sizes above 52 inches in length, and not making more than 81 inches will be charged in the 84 united inches' bracket.

Per square foot, net cash.

Greenhouse, Skylight, and Floor Glass.

$\frac{1}{8}$ Fluted plate........18@20
1-16 Fluted plate........20@22
$\frac{1}{4}$ Fluted plate........25@27
$\frac{1}{4}$ Rough plate........22@24
$\frac{3}{8}$ Rough plate........
$\frac{1}{2}$ Rough plate..........30@35
$\frac{3}{4}$ Rough plate..........60@65
$\frac{7}{8}$ Rough plate..........70@75
1 Rough plate..........80@85
$1\frac{1}{4}$ Rough plate.......1.30@1.35

PAINTING AND GLAZING (*Continued*).	Approximate Price.	Correct Price.
Wholesale Prices of Paints and Oil in New York.		
Chalk block........................per ton	3.50	
Chalk in bbls........................per 100 lb.	0.40	
China clay........................per ton	22.00	
Whiting, gilders, etc................per 100 lb.	0.75	
Whiting, common.................. "	0.55	
Paris white, Eng.................. "	2.00	
Paris white, American........................	1.00	
Lead, white, American, dry....................	$0.06\frac{3}{4}$	
Lead, white, American, in oil pure.............	$0.07\frac{1}{4}$	
Lead, English, B.B., in oil....................	0.09	
Lead, red, American........................	$0.06\frac{5}{8}$	
Litharge, American........................	$0.06\frac{1}{2}$	
Litharge, English........................	$0.09\frac{5}{8}$	
Ochre, French, dry........................	$0.01\frac{1}{2}$	
Venetian red, American........................	$0.01\frac{1}{4}$	
Venetian red, English........................	$0.01\frac{1}{2}$	
Tuscan red, English........................	0.18	
Turkey red, English........................	0.15	
Indian red........................	0.07	
Vermilion, Am. lead........................	0.12	
Vermilion, English........................	0.52	
Carmine, American, No. 40....................	4.25	
Chrome yellow, in oil........................	0.20	
Orange mineral........................	0.10	
Paris green........................	0.18	
Sienna, raw (American)........................	0.03	
Sienna, Italian lump........................	0.04	
Sienna, Italian powdered........................	0.08	
Umber, American raw and powdered............	$0.02\frac{1}{2}$	
Umber, Turkey, lump........................	$0.01\frac{3}{4}$	
Umber, Turkey, powdered....................	0.05	
Drop black, English........................	0.15	
Drop black, American........................	0.14	
Prussian blue........................	0.60	
Ultramarine blue........................	0.25	
Chrome green........................	0.16	
Oxide zinc, American........................	$0.04\frac{3}{4}$	
Oxide zinc, French, V M G S..................	0.09	
Oxide zinc, French, V M R S..................	$0.07\frac{1}{8}$	

BELL HANGER.

	Approximate Price.	Correct Price.
Materials to be of the very best description.		
Bell hanger............................per day	2.50	
Assistant............................. "	1.50	
Bell, house............................per lb.	0.35	
Cranks, flat, mortise — Single............each	0.25	
Cranks, flat, mortise — Double........... "	0.30	
Cranks, flat, mortise — Treble............ "	0.33	
Cranks, brass, including brass headed nails or screws, all complete — Single...... "	0.30	
Cranks, brass, including brass headed nails or screws, all complete — Double..... "	0.35	
Cranks, brass, including brass headed nails or screws, all complete — Treble...... "	0.45	
Cranks, brass, plain, driving any kind...... "	0.07	
Bell pulls, brass or bronzed, including plate and screws, all complete.......... "	0.75	
do. do. with sunk plate....... "	0.90	
Strong brass slide pull.................. ... "	0.40	
Bell springs, steel, with carriages complete, including screws.... — Single... "	0.25	
Bell springs, steel, with carriages complete, including screws.... — Double.. "	0.35	
Bell staples, strong wire, any size.......per doz.	0.03	
Bell wire, copper, any gauge.... ....per lb.	0.50	
Hanging bells, complete, labor only, including fixing wire, check springs and staples .... — First floor	0.75	
Hanging bells, complete, labor only, including fixing wire, check springs and staples .... — Second "	0.90	
Hanging bells, complete, labor only, including fixing wire, check springs and staples .... — Third "	1.25	
Church and turret bells..................per lb.		

ROOFING MATERIALS, INCLUDING LAYING, LABOR, AND ALL NECESSARY SCAFFOLDING.

	Approximate Price.	Correct Price.
Price per Square of 100 *feet Super.*		
Slating, not less than three inches cover, with annealed wrought iron nails..................		
Interlining between slating and boarding with —— plies of felt..............................		
Bedding slates in lime and hair mortar.........		
Covering with best 1C tin, laid and nailed complete, with tinned nails.....................	11.00	
Extras for cutting, fixing and securing to gables, chimney shafts, hips, valleys and ridges, round dormers, skylights and similar work.per ft. lin.	0.07	
Allow extra for standing groove, flat or soldered.		

ROOFING MATERIALS (*Continued*).	Approximate Price.	Correct Price.
Covered with best galvanized iron, laid and nailed complete, with galvanized iron nails, and painted under and over with one coat of anti-corrosive paint	12.00	
Extra for cutting, fitting and making fast to gables, etc. ... per foot lineal	0.07	
Shingles, well laid, 4½ inches to the weather	4.00	
do. do. if laid in mortar	5.00	
Covering to Flat Roofs with Felt, Composition and Gravel—per 100 feet Superficial.		
Laid complete in the best manner, and with the best materials; in any situaion, and not less than 10 gallons of composition to the square — 2 plies	4.00	
3 "	4.75	
4 "	5.25	
5 "	6.00	
Extra to be allowed for buildings over four stories in height		
Stripping off old gravel, repairing with felt and coating anew with composition and gravel	4.00	
Plastic Slate Roofing.		
Laid complete in the best manner, and with the best materials, in any situation — 3 plies	4.25	
4 "	5.00	
5 "	5.50	
Note.—If work is under 500 feet superficial the prices for roofing must be increased.		
Sundries.		
Repairing round chimneys, dormers, skylights, or against gables, with new fillets, felt and composition ... per yard lineal	0.25	
Prepared felt ... per lb.	0.03	
Composition for Coating ... per bbl.	3.00	
do. do. ... per gal.	0.20	
Gravel, fine clear grit ... per bush.	0.50	
Roofer and laborer included ... per day	3.75	
Eaves, Gutters and Conductors—all materials and fixed complete. Per Foot Lineal.		
Eaves gutters, semi-circular, of best tin (26 oz. per foot super.), with roll or wired edges, soldered joints, stopped ends, nozzled junctions for conductors, etc., above 500 feet lineal — 3 in. diam.	0.20	
4 " "	0.23	
5 " "	0.25	
6 " "	0.30	

ROOFING MATERIALS (*Continued*).		Approximate Price.	Correct Price.
Eaves, gutters, semi-circular, of best American galvanized plate iron, executed as above, including galvanized iron brackets...........	6 in. diam.	0.30	
	7 " "	0.35	
	8 " "	0.40	
	9 " "	0.45	
Rain water conductors of best tin (26 oz. per foot super.) with lapped and soldered joints, including tack bands, bends, elbows, shoes and galvanized iron fastenings...	3 " "	0.15	
	3½ " "	0.17	
	4 " "	0.20	
	5 " "	0.25	
	6 " "	0.30	
Rain water conductors of cast iron, including bends, elbows, shoes, wrought iron hold fasts, etc......	3 " bore	0.60	
	4 " "	0.70	
	5 " "	0.80	
	6 " "	0.85	
Stripping off and taking down old coverings, clearing out old nails, and removing and piling the stuff within a distance of 25 yards, per 100 feet super..............................		1.00	
WHOLESALE PRICES OF SOME ROOFING MATERIALS.			
Slate—Delivered in New York.			
Purple roofing slate......................per sq.		6.75	
Green slate................................		7.50	
Red slate..................................		11.75	
Black slate, Penn. (Jersey City)................		4.50	
Tiles, 1¼ in. rubbed..................per sq. ft.		0.25	
Tin Plates—Duty 1 1-10*c. per lb.*			
I. C. charcoal, 10 x 14...................per box		6.50	
I. C. coke, 10 x 14...........................		5.75	
I. X. charcoal, 10 x 14		8.50	
I. C. charcoal, 14 x 20		6.50	
I. X. charcoal, 14 x 20		8.50	
I. C. coke, 14 x 20		5.62½	
I. C. coke, terne, 14 x 20........................		5.25	
I. C. charcoal, terne, 14 x 20		5.75	
Zinc—Duty, Sheet, 2½*c. per lb.*			
Sheet.................................per lb.		0.07½	
Tinners' Stock.			
Tin plate, I. C., 10 x 14, charcoal................		6.75	
Tin plate, I. X., 10 x 14, "		8.75	
Tin plate, I. C, 12 x 12, "		6.75	

ROOFING MATERIALS (*Continued*).	Approximate Price.	Correct Price.
Tin plate, I. X., 12 x 12, charcoal..................	8.75	
Tin plate, I. C., 14 x 20, "	6.75	
Tin plate, I. X., 14 x 20, "	8.75	
Tin plate, I. XX., 14 x 20, "	10.75	
I. C. roofing, 14 x 20, charcoal..................	6.25	
I. X. roofing, 14 x 20, "	8.25	
I. C. roofing, 20 x 28, "	13.00	
I. X. roofing, 20 x 28, "	17.00	
10 x 20 coke (for gutters), 250 sheets..............	9.50	
Lead.		
Pig, 5¼c.; bar, 6¾c.; lead pipe, 6¾c.		
Roofing Felt.		
No. 1 tarred roofing felt...................per lb.	0.02	
No. 2 " " " .... "	0.01¾	
Rosin sized sheathing.................. "	0.03¾	
Common dry " .... "	0.02¾	
Carpet felt....................... .... "	0.03¾	
Roofing pitch...........................per gall.	0.06	
Extra heavy tarred roofing or sheathing felt, per 100 square feet...........................	0.75	
Anchor brand "natural asphalt" sheathing felt.....................per roll of 320 sq. feet.	1.75	
Extra heavy Anchor brand sheathing, per 100 square feet................................	1.10	
Miscellaneous.		
Roofing nails, wrought iron, clout plain...per lb.	0.17	
do. do. do. galvanized........ "	0.20	
do. do. do. tinned........... "	0.30	
Sheet iron, any gauge, for roofing....per 100 lbs.	5.50	
do. do. galvanized.... "	6.00	
do. do. corrugated.... "	8.00	

Prices of Miscellaneous Sundries Required about Buildings.

STANDARD WROUGHT IRON LAP WELDED STEAM AND GAS PIPE.

Inside Diameter Inches.	Plain, Price per Ft.	Enameled or Galvanized, Price per Foot.	Outside Diameter Inches.	Weight per Foot.
$\frac{1}{8}$	$0.08		.40	.24
$\frac{1}{4}$	08	$0.11	.54	.42
$\frac{3}{8}$	09	12	.67	.56
$\frac{1}{2}$	11	15	.84	.85
$\frac{3}{4}$	13½	19	1.05	1.13
1	19	28	1.31	1.67
1¼	27	40	1.66	2.26
1½	33	47	1.90	2.69
2	46	64	2.37	3.66
2½	75	1.00	2.87	5.77
3	95	1.30	3.50	7.55
3½	1.25	1.70	4.00	9.05
4	1.50	2.05	4.50	10.73
4½	1.75	2.40	5.00	12.49
5	2.25	3.00	5.56	14.56
6	2.75	4.00	6.62	18.76
7	3.75		7.62	23.00
8	4.75		8.62	28.00
9	6.50		9.68	34.40
10	8.00		10.75	40.64
12	12.00			54.65

CORRUGATED SHEET IRON.

Wire gauge	16 to 20	22	24	26
Black, per lb	5¾	6	6	6¼
Galvanized, per lb	8¾	9¼	9¼	9½

GALVANIZED JUNIATA IRON.

Nos. 16 to 20,	22 and 24,	25 and 26,	27	28
List, 12	13	14	15	16

Discount, 30 per cent.

RUSSIA IRON.

Perfect, in full packs, 8 and 9 13
" " 10 13
" " 11 .... 12½
" 12 and 13 .... 12½

Less than full packs, add ½c.

PATENT PLANISHED IRON.

"A" Wood's pat., planished, Nos. 24 to 27....................$10\frac{1}{2}$
"B" " " " " 24 to 27.................... $9\frac{1}{2}$

Broken packs, $\frac{1}{2}$c. per lb. extra.

NAILS.

	Approximate Price.	Correct Price.
Extras in following list are to show the difference in cost of different sizes, and should be added to the rates quoted, or price of 10d. to 60d.		
10d., to 60d. nails, fence and brads.......per keg	3.50	
Above 10d. Nails.		
8d. and 9d. nails...............add to each keg	0.25	
6d. and 7d "	0.50	
4d. and 5d. "	0.75	
3d. "	1.50	
2d. "	2.75	
4d. fine "	1.75	
3d. " "	3.00	
2d. " "	3.75	
Clinch, all sizes............................	1.75	
Cut spikes, 3 to 8 inch	0.35	
Lining nails, $\frac{7}{8}$ inch.....................	4.50	
" " $\frac{3}{4}$ "	6.00	
Barrel " $1\frac{1}{2}$ "	0.75	
" " $1\frac{3}{8}$ "	1.00	
" " $1\frac{1}{4}$ "	1.50	
" " $1\frac{1}{8}$ "	1.75	
" " 1 "	2.50	
" " $\frac{7}{8}$ "	3.00	
" " $\frac{3}{4}$ "	4.00	
Above Common Nails of same Size.		
Cut boat spikes............................	0.75	
Tobacco, 6d. to 10d........................	0.50	
Casing and box, 4d. to 20d..................	0.75	
Finishing, 4d. to 20d.......................	1.25	
Slating, 2d. to 5d..........................	0.25	
Each half keg, 10 cents extra.		

VERTICAL WHEEL HOT AIR REGISTERS AND VENTILATORS.

Size of Opening.	No. 1 Best Black Register.	Ventilator White or Black for Cords.	Register Without Valves.	Register Face Japanned.	Iron Border Frames.
4 x 10	$2.00	$2.25	$1.20	$0.60	
6 x 8	2.10	2.35	1.20	0.75	$1.05
6 x 10	2.40	2.65	1.50	0.85	1.20
8 x 10	2.90	3.15	2.10	1.20	1.50
9 x 12	3.85	4.10	2.40	1.40	1.55
10 x 14	4.80	5.05	3.30	2.10	1.90
12 x 15	6.00	6.25	3.70	2.35	2.10
14 x 22	9.60	9.90	6.00	3.80	3.15

Intermediate sizes at intermediate prices.

ANTI-FRICTION SLIDE CENTRE ROUND REGISTERS.

Size of Opening.	No. 1 Best Black Register.	Ventilator White or Black for Cords.	Register without Valves.	Register Face Japanned.	Iron Border Frames.
8 inch.	$2.00	$2.30	$1.32	$0.75	$1.00
10 "	2.95	3.25	1.70	1.15	1.30
12 "	3.85	4.15	2.30	1.45	1.55
14 "	4.75	5.05	3.00	1.75	1.95
16 "	6.35	6.65	4.15	2.65	2.35
18 "	7.65	8.00	4.95	3.30	3.15

Round ventilators or Registers for side walls, 7 inch...each $1.45
Smoke pipe, 7 inch hole.............................. " 3.00
Cast iron stove pipe thimbles, variety of sizes........per lb. 0.04½

SQUARE KITCHEN SINKS.

Sizes.	Plain.	Galvanized.	Enameled.
16½ x 12½ 5 in deep.............	$0.90	$2.00	$4.50
18 x 12 6 "	1.10	2.30	4.75
16 x 16 6 "	1.20	2.80	5.25
22 x 14 6 "	1.30	2.90	5.75
23 x 15 6 "	1.35	3.00	6.25
25½ x 15½ 6 "	1.40	3.15	6.50
20 x 12½ 6 "	1.25	2.80	5.25
20 x 14 6 "	1.30	2.90	6.25
24 x 14 6 "	1.40	3.30	6.50

SQUARE KITCHEN SINKS (*Continued*).

Sizes.	Plain.	Galvanized.	Enameled.
24½ x 16 6 in. deep............	$1.50	$3.50	$6.75
24 x 18 6 "	1.60	3.75	7.00
25½ x 17½ 6 "	1.60	3.75	7.50
27 x 15 6 "	1.65	3.75	7.75
24 x 20 6 "	2.00	4.50	8.00
28 x 17 6 "	1.90	4.25	8.00
28 x 20 6 "	2.00	4.70	8.50
30 x 16 6 "	1.90	4.25	8.50
30 x 18 6 "	2.10	4.70	8.75
30 x 20 6 "	2.40	5.60	9.50
32½ x 18 6 "	2.50	5.60	9.50
32½ x 21 6 "	2.60	6.20	10.00
36 x 18 6 "	2.60	6.00	10.00
36 x 21½ 6 "	3.00	6.80	11.00
38 x 20 6 "	3.30	7.00	11.50
42 x 22 6 "	3.50	8.00	12.50
48 x 20 6 "	4.30	9.75	14.00
48 x 23 6 "	4.50	10.50	15.00
24 x 14 8 "	2.25	4.75	8.00
30 x 24 8 "	4.00	9.50	13.00
50 x 24 6½ "	5.75	13.00	18.00
50 x 26 6½ "	6.00	14.00	20.00
62 x 22 8 "	9.00	18.50	26.00
76 x 22 7 "	13.50	28.00	32.00
56 x 32 9 "	14.00	31.00	32.00
60 x 28 10 "	17.00	33.00	35.00
78 x 28 10 "	20.00	42.00	45.00
94 x 24 10 "	25.00	50.00	
120 x 22 6 "	28.00		

SOAP STONE TUBS.

	Approximate Price.	Correct Price.
2 parts, length 4 feet; width 2 feet; depth 16 in.	26.00	
2 " " 4 " 6 in. " 2 " " 16 "	29.00	
2 " " 5 " " 2 " " 16 "	32.00	
3 " " 6 " " 2 " " 16 "	40.00	
3 " " 6 " 6 in. " 2 " " 16 "	43.50	
3 " " 7 " " 2 " " 16 "	47.00	
3 " " 7 " 6 in. " 2 " " 16 "	55.00	
4 " " 8 " " 2 " " 16 "	65.00	

BATH TUBS.

	Approximate Price.	Correct Price.
Length 5 feet; width 2 feet; depth 18 in........	47.00	
" 6 " " 2 " " 20 "........	54.00	

SINKS.

	Approximate Price.	Correct Price
2 feet long; 18 in. wide; 7 in deep..............	10.00	
2 " 6 in. long; 19 in. wide; 7 in. deep.........	11.00	
3 " " 20 " " 7 " "	12.00	
3 " 6 " 22 " " 7 " "	13.00	
4 " " 24 " " 7 " "	16.00	

STANDARD HOISTING ROPES FOR ELEVATORS WITH 19 WIRES TO THE STRAND.

IRON.

Trade No.	Circumference in Inches.	Diameter.	Weight per foot in lbs. of rope with Hemp Cen	Breaking strain in tons of 2,000 pounds.	Proper working load in tons of 2,000 lbs.	Circumference of hemp rope of equal strength.	Min. size of drum or sheave in feet.	Price per foot, in cents
1	$6\frac{3}{4}$	$2\frac{1}{4}$	7.80	74	15	$15\frac{1}{2}$	8	98
2	6	2	6.02	65	13	$14\frac{1}{2}$	7	76
3	$5\frac{1}{2}$	$1\frac{3}{4}$	5.08	54	11	13	$6\frac{1}{2}$	60
4	5	$1\frac{5}{8}$	4.10	44	9	12	5	50
5	$4\frac{3}{8}$	$1\frac{1}{2}$	3.10	35	7	$10\frac{3}{4}$	$4\frac{1}{2}$	41
6	4	$1\frac{1}{4}$	2.44	27	$5\frac{1}{2}$	$9\frac{1}{2}$	4	33
7	$3\frac{1}{2}$	$1\frac{1}{8}$	1.95	20	4	8	$3\frac{1}{2}$	27
8	$3\frac{1}{8}$	1	1.50	16	3	7	3	22
9	$2\frac{3}{4}$	$\frac{7}{8}$	1.14	$11\frac{1}{2}$	$2\frac{1}{2}$	6	$2\frac{3}{4}$	19
10	$2\frac{1}{4}$	$\frac{3}{4}$	0.83	8.64	$1\frac{3}{4}$	5	$2\frac{1}{2}$	15
$10\frac{1}{4}$	2	$\frac{5}{8}$	0.65	5.13	$1\frac{1}{4}$	$4\frac{1}{2}$	2	13
$10\frac{1}{2}$	$1\frac{5}{8}$	9–16	0.44	4.27	$\frac{3}{4}$	4	$1\frac{3}{4}$	12
$10\frac{3}{4}$	$1\frac{1}{2}$	$\frac{1}{2}$	0.35	3.48	$\frac{1}{2}$	$3\frac{1}{2}$	$1\frac{1}{2}$	10

Tiller rope $\frac{5}{8}$ inch diameter, 16 cents per foot.
" " $\frac{1}{2}$ " " 12 " "

CAST STEEL.

Trade No.	Circumference in inches.	Diameter.	Weight per foot in lbs. of rope with Hemp Cen	Breaking strain in tons of 2 000 pounds.	Proper working load in tons of 2,000 lbs.	Circumference of hemp rope of equal strength.	Min. size of drum or sheave in feet.	Price per foot, in cents.
1	$6\frac{3}{4}$	$2\frac{1}{4}$	7.80	107	22		9	165
2	6	2	6.02	97	20		8	128
3	$5\frac{1}{2}$	$1\frac{3}{4}$	5.08	78	17	$15\frac{3}{4}$	$7\frac{1}{2}$	100
4	5	$1\frac{5}{8}$	4.10	64	13	$14\frac{1}{2}$	6	83
5	$4\frac{3}{8}$	$1\frac{1}{2}$	3.10	52	11	13	$5\frac{1}{2}$	66
6	4	$1\frac{1}{4}$	2.44	39	8	$11\frac{1}{2}$	5	57
7	$3\frac{1}{2}$	$1\frac{1}{8}$	1.95	30	6	10	$4\frac{1}{2}$	42
8	$3\frac{1}{8}$	1	1.50	24	5	$9\frac{1}{4}$	4	34
9	$2\frac{3}{4}$	$\frac{7}{8}$	1.14	20	4	8	$3\frac{3}{4}$	28
10	$2\frac{1}{4}$	$\frac{3}{4}$	0.83	13	3	$6\frac{1}{2}$	$3\frac{1}{2}$	23
$10\frac{1}{4}$	2	$\frac{5}{8}$	0.65	9	2	$5\frac{1}{4}$	3	20
$10\frac{1}{2}$	$1\frac{5}{8}$	9–16	0.44	$6\frac{1}{2}$	$1\frac{1}{2}$	$4\frac{3}{4}$	$2\frac{3}{4}$	17
$10\frac{3}{4}$	$1\frac{1}{2}$	$\frac{1}{2}$	0.35	$5\frac{1}{2}$	1	$4\frac{1}{2}$	2	15

Bessemer and Siemens—Martin steel ropes at same price as iron ropes.

Note.—The prices given are for *Hemp Centre Ropes.* When made with *Wire Centre,* the price per foot is 10 per cent. extra. The weight of Wire Centre Ropes is 10 per cent. more than that of Ropes with Hemp Centres.

Notes on the Uses of Wire Rope.—Two kinds of wire rope are manufactured. The most pliable variety contains wires in the strand, and is generally used for hoisting and running rope. The ropes with 12 wires and 7 wires in the strand are stiffer, and are better adapted for standing rope, guys and rigging. Orders should state the use of the rope, and advice will be given. Ropes are made up to 3 inches in diameter, both of iron and steel, upon special application.

For safe working load, allow one-fifth to one-seventh of the ultimate strength, according to speed, so as to get good wear from the rope. When substituting wire rope for hemp rope, it is good economy to allow for the former the same weight per foot which experience has approved for the latter.

Wire rope is as pliable as new hemp rope of the same strength; the former will therefore run over the same sized sheaves and pulleys as the latter. But the greater the diameter of the sheaves, pulleys or drums, the longer wire rope will last. In the construction of machinery for wire rope, it will be found good economy to makes the drums and sheaves as large as possible. The minimum size of drum is given in a column in the preceding table.

Experience has demonstrated that the wear increases with the speed. It is therefore better to increase the load than the speed.

Wire rope is manufactured either with a wire or a hemp centre. The latter is more pliable than the former, and will wear better where there is short bending. Orders should specify what kind of centre is wanted.

Wire rope must not be coiled or uncoiled like hemp rope. When mounted on a reel, the latter should be mounted on a spindle or flat turn-table to pay off the rope. When forwarded in a small coil without reel, roll it over the ground like a wheel, and run off the rope in that way. All untwisting or kinking must be avoided.

To preserve wire rope, apply raw linseed oil with a piece of sheepskin, wool inside; or mix the oil with equal parts of Spanish brown or lamp-black.

To preserve wire rope under water or under ground, take mineral or vegetable tar, and add 1 bushel of fresh slaked lime to 1 barrel of tar, which will neutralize the acid. Boil it well, and saturate the rope with the hot tar. To give the mixture body, add some sawdust.

In no case should *galvanized rope* be used for running rope. One day's use scrapes off the coating of zinc. and rusting proceeds with twice the rapidity.

The grooves of cast iron pulleys and sheaves should be

filled with well seasoned blocks of hard wood set on end, to be renewed when worn out. This end wood will save wear and increase adhesion. The smaller pulleys or rollers which support the ropes on inclined planes, should be constructed on the same plan. When large sheaves run with great velocity, the grooves should be lined with leather, set on end, or with India rubber. This is done in the case of all sheaves used in the *transmission of power* between distant points by means of rope, which frequently run at the rate of 4,000 feet per minute. Full information may be obtained on the size of rope and the size and speed of sheaves to be used for transmitting power, where the ropes are made.

Steel ropes are, to a certain extent, taking the place of iron ropes, where it is a special object to combine lightness with strength.

But in substituting a steel rope for an iron running rope, the object in view should be to gain an increased wear from the rope rather than to reduce the size.

STEAM PRESSED VITRIFIED DOUBLE GLAZED DRAIN PIPES.

Pipe, per Foot.		Bends and Elbows. Each.	Branches. Single.	Branches. Double and V.	Traps, Each.
2 inch,	$ .13	$ .40	$ .48	$ ——	$1.00
3 "	.16	.50	.61	——	1.25
4 "	.20	.65	.75	1.30	1.75
5 "	.25	.85	.90	1.55	2.50
6 "	.30	1.15	1.05	1.80	3.50
7 "	.35	1.50	1.20	2.05	5.00
8 "	.45	2.00	1.45	2.45	6.00
9 "	.55	2.50	1,70	2.85	7.00
10 "	.70	3.00	2.00	3.30	8.00
12 "	.80	3.75	2.52	4.24	10.00
15 "	1.25	5.00			
18 "	1.60	7.50			

Double and V.: When longer than 1 foot, the excess to be charged as pipe.

House Branches per lineal ft.		Sewer Branches. per lineal ft.	
15 x 6	$1.75	15 in.	$2.25
18 x 6	2.50	18 "	3.00

Reducers and Increasers—Price of Bends measured at largest opening.
Syphons—Price of Bend and one foot of Pipe added.
Offsets—One-half the price of Traps.
Slants—Price of one and one-half feet of Pipe.
Collared Pipe, in lengths of 2 feet, from 2 to 12 inches inclusive.
Pipe with Rings, in lengths of 3 feet, from 10 inches upwards.

PUMPS.

DESCRIPTION.	Approximate Price.	Correct Price.
Iron Cistern Pitcher Spout Pump. Suitable for Iron or Lead.		
Boxes from $2\frac{1}{2}$ to $4\frac{1}{2}$ in. Suitable for 1 to $1\frac{1}{2}$ in. pipe ....each	4.00 to 6.00	
Iron Close Cistern Pump.		
Boxes from 2 to 3 in., suitable for 1 to $1\frac{1}{2}$ in. pipe ....each	3.50 to 5.50	
Douglass Cistern Pump.		
Boxes from 2 to 3 in., suitable for 1 to $1\frac{1}{2}$ in. pipe ....each	3.50 to 5.50	
New Style Side Cistern.		
Boxes from 2 to 3 in., suitable for 1 to $1\frac{1}{2}$ in. pipe ....each	3.50 to 5.50	
Cistern and Well Pump.		
From $2\frac{1}{2}$ to 4 inch cylinders, bored and polished ....each	10.00 to 15.00	
Tight Top Cistern and Well Pump. With Cast Iron Set Lengths.		
From $2\frac{1}{2}$ to $3\frac{1}{2}$ inch cylinders, bored and polished ....each	12.00 to 13.50	
Extra long sets ....each	0.50	
Braced Deep Well Pump.		
From $2\frac{1}{2}$ to $3\frac{1}{2}$ in. cylinders, bored and polished ....each	20.00 to 28.00	

PUMPS (*Continued*).

DESCRIPTION	Approximate Price.	Correct Price.
Engine Well Pump. With Cast Iron Set Length.		
From 2½ to 4 inch cylinders, bored and polished......each	22.00 to 27.00	
Engine Well Pump. With Gas Pipe Set Length		
From 2½ to 4 inch cylinder, bored and polished......each	21.00 to 26.00	
Double Acting Force Pump. For Railroads, Distilleries, etc.		
For Hand and Power.		
From 4 to 8 inch cylinder. Stroke 8, Gallons per minute, 40 to 80......each	75.00 to 135.00	
Hydraulic Rams.		
Four Sizes.		
From 2 to 14 gallons per minute, drive 25 to 50 feet where desired etc......each	9.00 to 20.00	
Green House Engines.		
For garden use......each	25.00	
For green house, including pail, 3 ft. hose and discharge pipe......each	10.00	
Less pail......each	8.00	
Base Force Pumps. Bored and Polished.		
No. 1 from 2½ to 4 in. bore. Iron cylinder......each	$9 to 14	
No. 1 from 2½ to 4 in. bore. Brass......"	14 to 28	

REMARKS.

It must be understood that the foregoing prices are only approximately correct, and are subject to market fluctuations and local demand. They are only given as a guide to the estimator where the actual current market prices are not obtainable.

The most successful contractors are those who "figure" close, not overlooking a single item, and then adding from 15 to 30 per cent. to the aggregate for profits and contingencies.

The amount of percentage added, depends in a great measure on circumstances. Sometimes a contractor may be so full of work that he does not care to take more unless he gets an extra good price for it; then he will add on his estimate a large percentage. Again, it may be that he has little to do and will be compelled to take work at the lowest possible paying prices.

In these days of keen competition men are often led to accept contracts much lower than the work can possibly be completed for; then they will endeavor to make up the difference by either overworking their employees, reducing their wages, or "scamping" the work. The adoption of either of these expedients will surely end in ruin and destruction to the contractor; better not take the work at all, if a good paying price cannot be obtained for it.

Builder's Bookkeeping.—Builders generally should habituate themselves to reduce their buisness to a reliable system of accounts, and accustom themselves to regard their operations from the standpoint of close and careful calculation.

The simplest phase of the building business is, that in

which the master builder acts merely as an overseer or superintendent of the work, and does not undertake to perform in person any specific task. Where all the different items of work, including mason's and carpenter's work, are given out in contracts, the arrangement of these items of detailed cost in a consolidated result is a simple matter of arithmetic. The work becomes more complicated where either the mason or carpenter work, or both, is undertaken in person by the master builder operating through foremen and employed mechanics. To make the cost of such works tally with the other items of cost, it becomes necessary to keep a very close watch over expenditures, or there will be many and large discrepencies.

Some builders undertake to perform with their own hired mechanics a great variety of work connected with house building, such as the painting, plastering, brick and stone work, and carpenter work. In these cases the accounts become very voluminous and complicated, and the employment of a skilled book-keeper becomes imperative.

The items of work which are given out in separate contracts present little difficulty, as these may be readily formulated. A strict record should be kept of payments made to the several sub-contractors on account of their contracts. An ordinary memorandum book, such as may be purchased on the streets or at the stationer's, will suffice for this purpose. One page in such a book should be devoted to each individual contract, and should be headed with the name of the sub-contractor. On such a page should be entered the date and amount of each partial payment of the contract price. This will enable the builder to see at a glance how much has been paid and how much is due upon a given contract. We may add, that such an account faithfully kept will constitute acceptable evidence in any court of law.

The accounts of mason and carpenter work call for greater minutiæ and particularity. Separate and accurate pay-rolls should be kept for each job, whether the work performed may be done on the premises where the improvement is being made, or away from them. In carpenter work, especially, the pay-roll of all shop work should be properly apportioned and distributed among the several jobs, and each sub-division charged under its appropriate head in the book of each job. The rule should be rigidly enforced of requiring all material men to furnish separate itemized bills for material sent to any particular job, or intended to be used for a specific job. As these bills are received their totals should be entered on the account book under the appropriate heading, whether for carpenter or mason work.

A page in the memorandum book should be devoted to all the incidental expenses not appertaining to the mechanical portion of the work, such as interest, taxes, legal and architectural fees, brokerages, etc.

Such a system of accounts really embraces all that is necessary to furnish a builder with an intelligible view of the cost of his work as it progresses. It would be well to devote a page in this book to a record of any notes which may be given out, indicating their dates of maturity and amounts.

The only further suggestion to make is that a monthly balance sheet should be taken off in a form which we will indicate. This balance sheet will consist of an enumeration of the headings of all these accounts. Three parallel columns will be required to display the needful data. In the first column, opposite its appropriate heading, may be stated the total amount of each contract as made, or the assumed cost of the item of work. In the second column may be given the amount paid on account of each item. In the third column may be stated the difference between the respective

amounts in the second and first columns—which will be the amounts unpaid and due on each item of work, and the total of these differences will be the whole amount unpaid on the job. This balance sheet will enable the builder to perceive at a glance the precise financial position of his job, and will constitute besides a faithful monitor of the accruing costs and their distribution.

We submit this form of balance sheet without any further explanation, believing that it will commend itself to the approval of painstaking builders, and as here presented will be self-explanatory.

BUILDER'S BALANCE SHET.

Heads of Accounts.	Amounts of Contracts and estimated cost.		Amounts paid on Account.		Balances due.	
Brown stone work.............	$		$		$	
Bells and tubes................						
Blinds, inside and outside.....						
Blue stone work...............						
Carpenter work, including—						
Hardware.						
Labor						
Timbers						
Trimmings..................						
Dumb waiters..............						
Framing....................						
Sash and sylights...........						
Glass, plate—sheet and fancy.						
Doors—hardwood and pine...						
Hardwood mantels...........						
Mirror frames and cornices...						
Wainscoating................						
Iron work, ...						
Plasterer's work...............						
Roofer's work.................						
Furnace work.................						
Stair work.....................						
Gasfitting work...............						
Plumbing work...............						
Marble work..................						
Grate work..................						

BUILDER'S BALANCE SHEET (*Continued*).

Heads of Accounts.	Amounts of Contracts and estimated cost.		Amounts paid on Account.		Balances due.	
Range work..................	$		$		$	
Painting.....................						
Mason work, including—						
Excavating.................						
Bricks......................						
Labor						
Building stone....						
Lime and cement						
Interest account.............						
Taxes (if any).....						
Surveyor's fee...............						
Architect's fee..............						
Counsel's fee.........						
Insurance..................						
Coal..........						
Permits....................						
Watching..................						
Brokerage..................						
Totals................						

It will be seen by the foregoing lists that the prices given are not always the same for the same class of work or materials; this is accounted for by the fact that the first figures given are gathered from Southern and Western sources, while the latter are taken from Eastern and Middle State price lists; but the estimator should in no case rely on these rates alone if he can possibly obtain the local current prices.

We now enter in another department, and one that should be thoroughly understood by the estimator and contractor, to enable him to arrive at something like correct quantities.

Measurement of Artificers' Work.

We lay down certain general rules for the measurement of Artificers' work as generally practiced by experienced surveyors. There are, however, certain local customs which prevail in different places which have always been found difficult to overcome. No doubt but that measurement simply by the cubic, superficial, or lineal foot is the fairest way—irrespective of customs to the contrary—and if architects would commence the practice of inserting in their specifications and contracts that the work should be thus measured and paid for, it would soon become a recognized custom. All surveyors do not take their measurements in the same order, or keep their books in the same form. The following rules, however, will be convenient to observe:

Take the several parts of the work in the order most convenient, observing always to enter the length first, next the width, and lastly the depth or thickness.

Describe the nature of the material and workmanship, and the exact situation of the work. A strict observance of these rules will facilitate the future identification of the dimensions with the work from which they have been taken, should a reference be required to them in case of dispute.

EXCAVATORS' WORK.

At per cubic yard.

If paid for according to the schedule, keep the work under the different items separate. Trenches are usually kept separate.

DRAINS, INCLUDING PIPES, ETC.

At per yard running.

State the depth and size of pipe or drain.

ALLOWANCE FOR SLOPES.

Where the sides of an excavation will not stand vertically, allow 3 inches on each side for every foot in depth.

For pipes take the bottom of the trench about 9 inches wider than the diameter of the pipe.

SHORING AND STRUTTING, ETC.

It is better that when shoring or strutting becomes necessary, the contractor should provide for this in his estimate.

PUMPING.

When necessary, to be paid for per day labor.

CLAY PUDDLE OVER VAULTS AND ARCHES.

At per yard superficial.

State height of arches, and thickness of puddle required.

PILE DRIVING.

Number the piles, scantling, and length of feet to be driven, number the ringing, pointing, shoeing, and state the weight of the rings and shoes.

CONCRETE.

In thickness of 12 inches and over, *per yard cubic*, under pavings or hearths, or less than 12 inches thick, *per yard superficial.*

When concrete is lifted above ground, state the height.

MASON AND STONE CUTTER'S WORK.

Walls built of rubble stone are sometimes measured by the toise (French), which contains 87.16 cubic feet English; some measurers only allow 84 feet. Sometimes it is measured by the cord, 128 feet, sometimes by the perch, and again by the cubic foot. Walls under 1 foot 6 inches in width measured as 1 foot 6 inches work. Walls over 1 foot 6 inches, and not 2 feet 6 inches, are taken as 2 feet 6 inches in work. Footing courses are measured extra.

Face Work of a superior kind on rubble masonry is measured separately and described.

Quoin Stones of selected stones are allowed as block stone, and other dressings in a similar manner.

Walling of Block Stone is charged at per cubic foot, according to description, similar to ashlar prepared and set, including all beds and joints, but the face is charged extra at per foot superficial, according to the way it may be dressed.

ASHLAR WORK.

Definition of terms for the labor on stone.

Plain Work is the even surface produced without sinking more than necessary to remove the mere irregularities of the stone.

Sunk Work is the cutting or chiseling below the plain surface, as in rebating, or the weatherings of string courses, copings, and cornices.

Circular Work is that required to form convex or con cave surfaces, as to the shafts of columns, arch stones, or circular curbs.

Circular, Circular Work, is that required to form a sphere or a niche head.

Moulded Work, straight, is that to cornices, etc.

Moulded Work, circular, is that to the necking or capital of columns.

LABOR IN GENERAL.

It is the practice of most surveyors to take only one bed and one joint to each stone, and two if not sawn. It is best, however, to measure, and to state that such has been done, allow the largest dimensions for the cubic contents. One joint only to be allowed to every 3 feet in length when the work is continuous, as in strings, copings, etc. Take plain work rubbed to all faces and returned ends unless otherwise worked.

Girth the sunk work, moulded work, circular plain, and circular moulded work as it appears.

Take splayed and fair edges, under 6 inches wide, back joint, throating, grooving, sunk rebates, mitres to sinkings, chamfers, reeds, flutings, haunches, joggle and iron tongued joints, cutting and pinning to landings, etc., by *the foot run.*

Number fair ends to steps, pipe holes, cramps, plugs, dowels, mortise holes for door posts, rounded corners, notchings, letting in coal plates, air traps, sink stones, cutting and priming ends of steps, stopped and level ends to sinkings, mitres to mouldings, external and internal (according to girth) returned and mitred ends to copings, neckings to chimney pieces, etc.

REGULATIONS FOR THE MEASUREMENT OF MASONRY.

CUBE STONE. If square measure net size when worked, when not square measure the size of a square stone of the extent required. When the stones are of scantling 6 feet and upwards, measure separately.

DRAFTED BACKS. The back of stones where drafted to be measured according to actual work shown.

PLAIN AND SUNK BEDS. One plain bed only to be taken for each stone, except to mullions of windows, for which two beds are to be taken to each stone. Ordinary arch stones to be considered as having one plain bed and one sunk bed.

PLAIN AND SUNK JOINTS. Not more than one plain joint to be taken for each stone, having one or more plain joints. All plain joints to be taken as they occur.

CHISELED OR RUBBED FACES. To be measured to the size actually shown on the external surface.

ROUGH SUNK. To be taken when a large quantity of stone has to be removed, as in stop mouldings to sills, window heads, and other similar work.

Sunk, Chiseled or Rubbed Faces. To be measured on the surface actually worked, adding the depth of the sinking.

Stopped Sinking. To be measured in such situations as do not permit the work to be carried straight through the stone, as in the stop mouldings to sills, window-heads, and other similar work.

Preparatory Labor or Plain Face or Bed. To be taken wherever it is necessary to produce a face for the purpose of setting out under-work, as in tracery heads, and other similar works. This is also intended to apply to mullions of windows, one side and one edge of which are to be taken as plain bed.

Mouldings. To be girthed, the surface actually shown, the top bed, if weathered, only to be measured as sunk face.

Mouldings to Paneling. To be girthed, including the back panel.

Circular Face to Soffit of Cusps. To be measured the whole thickness of the stone from back to front.

Sunk Faces to Soffit of Cusps in Paneling. To be measured net on the face, adding the depth of the sinking from the external face.

Sunk Face in Margins for Eyes. To be measured the extreme length and width.

Circular Sunk to Rebated Soffit of Cusps. To be measured from the external surface, adding the depth of the rebate.

Mouldings in Tracery. The extreme length of the straight mouldings in the tracery of the window heads to be measured through the mitres and junctions with other mouldings.

Throat. To be measured per foot running.

Groove for Cement. do. do.

GROOVE FOR SASHES. To be measured per foot running.

REBATE NOT EXCEEDING 3 INCHES IN GIRTH. To be measured per foot running.

MITRES TO SINKINGS. To be numbered according to width.

MITRES AND RETURNS TO SINKINGS. To be numbered according to width of the sinking and length of the return.

MITRES TO MOULDINGS. To be numbered according to the girth of moulding.

MITRES AND RETURNS TO MOULDINGS. To be numbered according to the girth of the moulding, and length of the return.

STOPPED END OF MOULDINGS. To be numbered according to girth of moulding, and length of return.

STOPPED ENDS OF MOULDINGS OF SPLAYED SILLS AND SILLS OF PANELS. To be numbered according to the girth of the moulding and extreme length from top of sill to point of intersection.

ROUGH SINKINGS FOR CUSPED WINDOW HEADS and similar SINKINGS. To be numbered, taking the average area of the sinking and the full thicknesss of the stone.

CARVED STONE WORK is sometimes paid for by the piece or by the foot superficial. See pages 34, 35, 36, 37, 38, 39, and 40.

BRICK WORK.

This is measured generally by the one thousand bricks, laid in the wall. Sometimes, however, it is measured by the perch, and sometimes by the foot cubic, but not often. The following rule shows how the number of bricks may be found in walls of any thickness:

A	$4\frac{1}{2}$ in.	wall	requires	for each foot	superficial,	7	bricks.
A	9 in.	"	"	"	"	14	"
A	13 in.	"	"	"	"	21	"
A	18 in.	"	"	"	"	28	"

A 22 in. wall requires for each foot superficial, 35 bricks.

Add seven bricks for every half brick additional added to the thickness.

Deduct all openings for doors, archways, windows, gateways, or other large openings. Flues, ends of joists, girders, sills, lintels and boxes of sash frames, are generally counted solid, as the wastage of material and time in working around these places more than makes up the difference.

Rubbed brickwork and ornamental work must be measured separately and charged extra, unless otherwise provided for.

Tuck-pointing, drains, cisterns, wells, and paving, are done by the lineal, superficial or cubic foot, as may be agreed upon. See pages 40, 41, 42, 43 and 44.

PLASTERING.

All plain work is measured by the yard superficial. All mouldings, beads, cornices, and panel work is measured by the running foot, if one foot or less in girt. If more than one foot girt, charge by superficial foot. See pages 44, 45, 46 and 47.

CARPENTERS AND JOINERS' WORK.

As so much of this work is now done by machinery, no general rules can be laid down. The following memoranda, however, may be found useful:

Labor on timber is classified "*Fixed only*," "*Framed*," or "*Framed and Fixed*."

Timber fixed, includes the labor in nailing, spiking, halving, dovetailing or notching.

Timber framed, includes mortising and tenoning.

Reduce all timber to board measurement.

BOND TIMBER.

Take bond timbers, wall plates, pole plates, templates, and lintels under this head.

FLOORS NAKED.

Take all joists and sleepers which have not been actually framed as "fixed" only.

Keep ground joists and sleepers distinct from those to upper floors.

Girders, binders, trimmers, and trimming joists to be taken as framed.

Girders sawn down the middle, reversed and bolted, or trussed are to be kept separate.

Setting in screw-bolts, plates, etc., are to be numbered as extras.

Take strutting between the joists by the foot running, state the scantling, and if herring bone or otherwise.

WOOD BRICKS, ETC.

Number the wood bricks and similar insertions into wall.

ROOFS.

Take king posts, queen posts, principal rafters, and the beams, etc., as "framed in trusses."

Allow in length for each tenon.

Take common rafters, purlins, diagonal ties, dragon pieces, and gutter plates, except where actually framed as "fixed in rafters," etc.

Add to all iron work extra for fixing.

Take ridge, hips and valley pieces as framed—or otherwise measure boarding by the square of 100 feet superficial,

Hip and ridge rolls measure per foot running—state the diameter, and if spiked or otherwise.

PARTITIONS.

Take the head, sills, braces, studs, door heads, etc., as framed and trussed in partitions or otherwise, as the case may be.

Deduct for doorways.

Studs tenoned with the head and sill and spiked, are to be considered as framed.

Iron work and fixing extra.

ROUGH BOARDING.

Measure by the square of 100 feet superficial. If waste, allow for the same.

BRACKETING, ETC.

Take the actual measurements and allow for waste.

Number the pieces.

DOOR FRAMES.

See mill prices—(included with doors).

WROUGHT, FRAMED, AND ROUGH TIMBERS IN GENERAL.

Measured by the foot cube.

FLOORING.

Per square of 100 *feet super.*

Take the length by the width, add pieces filled in to windows, door openings, recesses, etc.

Deduct slabs, chimney breasts, and other projections.

Extras.—Take the glued and mitred border to slabs by the foot running.

SKIRTINGS.

Per foot running.

Take the round of the room, and add for the passing at angles.

State thickness and width—if moulded or otherwise, and if backings are included.

NARROW GROUNDS.

Take the length as described for the skirting.

State the thickness and width, and if chamfered, plugged to wall or otherwise.

SASHES AND SKYLIGHTS AND FRAMES.

See mill prices for sashes, including frames.

Extras.—Take the beads, stops, and linings by the foot running, according to thickness and width—and labor upon them.

State if sill is of oak, tamarac or pine—weathered or throated.

State mode of hanging sashes, quality of lines, pullies, weight, etc.

SASHES, CIRCULAR HEADS.

Provided for under mill work.

Extras.—The same as for square sashes.

WINDOW LININGS AND WINDOW BOARDS.

Take the length by the width in each case—allow for the passings—state thickness of linings.

For window boards and bearers, state thickness, also, if tongued to the sill and rounded on edge.

Extras.—Labor to grooves at per foot run.

FRAMED GROUNDS AND ARCHITRAVES.

Architraves supplied at the mill.

State the number of feet of groundings.

Count the number of mitres.

SHUTTERS AND BACKFLAPS.

Shutters and backflaps furnished at mill.

Describe how made, panels, etc.

Extras.—Hinges, shutter bar or bolts, knobs, etc.

WINDOW BACKS, ELBOWS AND SOFFITS.

Part supplied at mill.

Describe that part done by hand labor.

BACK LININGS.

To the height for the shutters add 2 inches, for that of the back lining, by the width.

State thickness and how worked.

BOXING.

Take the height, by the width, including the framings.

State the thickness, and if wrought, framed, rebated, beaded or splayed; if they are termed "proper boxings."

SLIDING SHUTTERS.

Shutters provided at mill.

State size of pulley pieces and beads, quality of line weights and pulleys.

Boxings, grounds, etc.—to be taken as for window fronts.

Take the fastenings, and flush rings to the shutters and hinges to flaps.

OUTSIDE SHUTTERS.

Provided at mill.

Extras, scribing and fixings.

DOOR-FRAMES, ARCHITRAVES.

All kinds of doors, frames and architraves being made by mill work, it is only necessary to state the sizes and thickness, etc.

Extras—such as sills (state if oak)—hanging—fixing architraves—hinges—locks, etc.

STAIRCASES.

It is customary for the contractor to take staircases at so much per step, which includes every thing complete—according to a specification.

The following is the rule for measuring them:

Take the extreme length of the head, including the hous-

ings into the strings, by the collected widths and heights of the heads and risers, measured from the front of the risers to the nose of the tread for the other.

State thickness of the treads and risers with the number and sizes of the carriages (if any).

State if the steps are wrought, glued, or blocked, if with moulded or rounded nosing, if cut and mitred to string, or housed to string, at one or both ends, as the case may be.

Extras. Take the bottom step separately, if longer, or with curtail end.

Take grooving and tongueing by the foot running—also take run of nosing on the floor to form the upper steps.

Take housings to the steps and risers.

Dovetailed sinkings for balusters.

Number of returned brackets according to description.

Take all fascias apron linings, by the foot superficial, according to description.

Staircase (*Winders*).

Take the whole space occupied by winders.

Collect the lengths of risers by height, plus 1 inch for each nosing on winders.

State the thickness, etc., as pointed out for the flyers.

Extra. Take the grooving and tongueing by the foot running.

Number the housings to the winders, and keep them separate from those of the flyers, also the returned circular nosings to the steps, and the number of circular cut brackets.

STRING BOARDS.

Take the extreme length, including the framings, etc., by the width, keep the parts that are wreathed separate.

State the thickness of strings, if framed, rebated and beaded, if sunk or double sunk, if moulded, if cut and mitred to risers;

also, if solid wreathed, or wreathed in thickness, or cylindrical mould with proper backings.

State if circular parts are under 6 inch railings.

Extras. Number of ramps (Extra to the measurement).

" tongued angles.

" housings.

" splayed ends.

HANDRAILS.

Take the length along the middle of the rail—keep separate the parts that are straight, ramped, wreathed and circular.

State the thickness, if moulded or otherwise, and if the circular or wreathed parts are to well holes of less than 12 inches opening, it must be stated.

Extras. Sinking for iron covers, straight or circular, at per foot running.

Number of handrail screws and fixing.

Number of scroll ends or moulded caps to newels.

Screw nut and joint to cap.

NEWELS.

Take the height including tenons.

State the size, and if turned-octagon, or otherwise.

Extras. Number of turned pendants.

Iron screw bolt and fixing.

BALUSTERS.

State size—square, turned, carved or otherwise, if screwed or dovetailed, etc.

Extras. Iron balusters if used inside of wood, screws and fixing.

WATER CLOSETS.

Per foot superficial.

Describe separately seat, flap, frame, skirting, thickness of woods, etc.

Take hinges according to description.

Holes for handle, hole for pan, and if properly dished.

CISTERN.

Describe frame work, casing, etc.

SMITH AND FOUNDER'S WORK.

Iron work is usually charged by weight; it does not matter in what form the measurements are taken provided the surveyor obtains the correct quantity in feet or inches.

Keep each article separate, according to description.

CAST-IRON. Take a pattern for each description of cast-iron.

Take chipping, filing and fitting extra.

WROUGHT-IRON. Measure by the foot superficial, and reduce to weight.

Take the number of holes drilled for bolts, rivets or otherwise, according to the thickness of the iron.

Number the bolts when small, and the rivets according to size.

PLUMBER'S WORK.

In measuring lead the dimensions should be carefully taken, the material being heavy and expensive, and small errors in the superficial dimensions become serious when reduced to weight.

Lead, including the labor of laying gutters, flats and flashings, is usually charged by the cut—and under one head.

Lead work to cesspools, cisterns, sinks, etc., in the same manner as for gutters, etc., but separate.

Soldering to joints, angles, etc., and nailing, at per foot running.

Take pipes at per foot running according to the diameter and weight, take the joints extra.

Number all cocks and fixing according to size.

Give an accurate description of each.

Take plugs, washers and wastes, air-traps, gratings, screw or driving ferrules, etc., and fixing, according to description and size.

Give an accurate description of each water closet, the traps and mode of fixing, etc.

Take making good to soil and other pipes extra.

Pumps and fixings at so much each.

Take the suction and supply pipes, and making good, the same to the pumps—also, wall hooks and fixing extra.

PAINTERS', GLAZIERS' AND PAPERHANGERS' WORK.

PAINTER. The rule observed in measuring is wherever the brush goes—and to charge by the superficial yard, except where it beeomes necessary to work to a line, as in the case of skirtings, to prevent the floor or wall from being soiled, technically termed "cut on both edges."

In describing painters' work, state the number of oils, if knotted or stopped, flatted or otherwise, if in common or ornamental colors. If the latter, give the name of each.

Note. Common colors are red lead, venetian red, umber, spanish brown or any of the common ochres mixed with white lead and oil.

Ornamental colors are prussian blue, indigo, mineral green, the rich reds, pinks and yellow.

Take hand rail, iron bar, rain-water pipes, edges to shelves, edges of coping, stone strings, cornices, by the foot running.

Note. Strings, cornices or other work, when done from a ladder or scaffold, should be kept separate.

Number the sash panes (the outside only).

Sash squares (each side) per dozen.

Window sills, chimney pieces, newels, balusters, heads and

shoes to rain-water pipes, door scrapers, brackets, shutter bars, bolts, etc., at each.

Note. Take the inside of the sash frames, with the linings at per foot superficial.

Work difficult to be measured, such as the capitals to columns and other ornamental work, should be numbered and described, giving as clear an idea of the amount of labor upon them as possible.

Letters or figures are numbered according to the height of each in inches, and described as plain or ornamental.

GLAZIER.

In measuring glass take the dimensions from rebate to rebate each way, when the panes are square, if irregular or circular take the extreme dimensions as if they were square—keep large squares separate.

Describe the glass according to quality.

Plate glass is generally paid at a price agreed upon—with or without a guarantee against breakage.

PAPERHANGING.

Is paid for by the number of pieces.

Odd yards charged as one piece.

Take as extra, pumicing and preparing walls, lining paper and hanging same.

Take borders and hanging at per dozen yards running.

ROOFING—SLATE OR METAL.

Measure slating to roofs by the square of 100 ft. superficial, give the size and usual denomination of slates, their gauge and description of nails used. State if circular or upright, but make no allowance for circular work in the measurement as the additional labor should be paid for in price.

The dimensions in slating are usually taken along the eaves

in front and rear, to the extreme ends by the width from the eaves to the ridge, whether the roof is hipped or valleyed.

Deduct all openings, such as chimney shafts or dormers but allow the run of the edge along the same by 6 inches for cutting and waste.

Add for all raking edges and irregular angles the length by 6 inches, and for hips and valleys the length by 6 inches on each side.

It is usual to allow for the undercourse to eaves and gutters, the length by the gauge of the bottom course, on the supposition that an extra length of slate is used.

Run all filleting, and state if in mortar or cement.

Slate Skirtings and Covers to hips and ridges are taken at per foot running according to thickness of the slate, state if bedded in putty or red lead.

State the weight of lead in gutters, flats and flushings, which should be carefully done, as small errors in superficial dimensions, on account of the expensive material, become serious when reduced to weight.

Note. The same method of measuring applies to all metal roofing.

It is usual for architects to receive tenders for roof coverings, gutters, etc., at a fixed price, which includes all extras, such as nails, holes to slates, etc., etc. The above method, as adopted in England, is given as a guide in case of disputes when no fixed price or mode of measurement has been stipulated by the architect.

GRAVEL ROOFING.

Measure gravel roofing by the square of 100 feet. State the number of plies of tarred felt, and quantity of pitch and gravel used to the square. Make no deductions for traps in roof under nine superficial feet.

GAS FITTERS' WORK.

Take gas pipes, including fitting and fixing, by the foot running, according to size. Take the number of elbows, crosses, T pieces, reducing sockets, outlets, etc., extra.

Take the meter, governors, syphon traps, pendants, etc., and fixing according to description.

Holes broken through walls and floors, and made good, are numbered according to the thickness of the wall.

Elements of the Mechanics of Architecture.

In works of this kind it is customary to introduce a number of rules and tables for obtaining the strength of materials, stability of structures, etc., etc. The custom is a good one, and it is proposed to follow it; and with this view the following short treatise on the above-named subjects, which has been carefully collated and corrected by F. E. Kidder, B.C.E., and who has kindly permitted the author to embody it in this work, is given along with other useful tables and memoranda.

It is proposed first to give such definitions as will enable the reader to easily comprehend what is to follow, and then to take up the subjects of the strength of materials and the stability of structures.

DEFINITIONS.

Force is that which produces or retards motion, or which tends to produce or retard motion.

Equilibrium is that condition of a body in which the forces acting upon it balance or neutralize each other. Such a body is at rest.

Structures are artificial constructions in which all the parts are intended to be in equilibrium.

Mechanics is that branch of Physics which treats of force as producing motion or equilibrium in bodies.

It is divided into

I. *Dynamics*, which treats of force as producing motion, and therefore of machines.

II. *Statics*, which treats of the laws of equilibrium, and is subdivided into

a. Statics of rigid bodies.

b. Hydrostatics.

In building we have to deal only with structures, which are treated of under the head of statics of rigid, or solid, bodies.

A *structure* consists of two or more solid bodies called *Pieces*, which are connected at portions of their surfaces called joints.

There are three conditions of equilibrium in a structure, viz.: ,

I. The forces exerted on each piece must balance each other. These forces are:

a. The weight of the piece.

b. The load it carries.

c. The resistance of its joints.

II. The forces exerted on the whole structure must balance each other.

These forces are:

a. The weight of the structure.

b. The load it carries.

c. The supporting pressures, or resistance of the fouudations, called external forces.

III. The forces exerted on each of the parts into which any piece may be supposed to be divided must balance each other.

Stability consists in the fulfilment of conditions I. and II., that is the ability of the structure to resist displacement of its parts.

Strength consists in the fulfilment of condition III., that is, the ability of a piece to resist breaking.

Stiffness consists in the ability of a piece to resist bending.

The theory of structures is divided into two parts, viz.:

1. That which treats of strength and stiffness, dealing only with single pieces, and generally known as "Strength of Materials."

2. That which treats of stability dealing with structures.*

PART I. STRENGTH OF MATERIALS.

In order that we may proceed intelligently, it will be necessary to define a few more terms. These definitions are of great importance, for the terms they define are constantly occurring in all works on strength of materials.

Strain. When a load or combination of external forces is applied to a piece of a structure, it produces a *strain*, or alteration of the volume and figure of the whole piece, and of each of its particles.

Stress is that combination of forces which the particles of the piece exert in resisting the tendency of the load to produce disfigurement and fracture. That is, *strain* tends to fracture a piece, and the *stress* exerted by the particles of that piece, tends to resist fracture.

The *Ultimate Strength, or Breaking Load* of a body, is the load required to produce fracture in some specified way.

The *Safe Load* is the load that the body can support without impairing its strength.

Factors of Safety. When not otherwise specified, a *factor*

*These definitions are taken from a sheet prepared by Prof. Babcock, for the architectural students at Cornell University.

of safety means the ratio in which the breaking load exceeds the safe load. In designing a piece of material to sustain a certain load it is required that it shall be perfectly safe under all circumstances, and hence it is necessary to make an allowance for any defects in the material, and for poor workmanship, etc. It is obvious that for materials of different composition, different factors of safety would be required. Thus iron being more homogeneous than wood, and less liable to defects, it does not require so great a factor of safety. And, again, different kinds of strains require different factors of safety. Thus a long wooden column or strut requires a greater factor of safety than a wooden beam. As the factors thus vary for different kinds of strains and materials, we will give the proper factors of safety for the different strains, when we are considering the resistance of the material to those strains.

DISTINCTION BETWEEN DEAD AND LIVE LOAD.

The term dead load, as used in mechanics, means a steady, quiescent load, as the weight of the material itself, or a load of stone or some *immovable* body.

A *live* load, means a moving load, as a crowd of persons, animals, boxes liable to frequent moving, etc.

Now, it has been found by experience that the effect of a live load on a beam, or other piece of material, is twice as severe as that of a dead load of the same weight, and hence a piece of material designed to carry a live load, should have a factor of safety twice as large as one designed to carry a dead load.

ELASTICITY OF BODIES, AND MODULUS OF ELASTICITY.

All bodies may be extended and compressed; and when the strain does not exceed a certain limit, they will recover

their original volume and figure when the force producing the extension or compression is removed.

Within this limit, called the *limit of perfect elasticity*, the extension or compression has been found by experiment to be directly as the force producing it. This is sensibly true of all solids, even for those so plastic as moistened clay.*

When the limit of elasticity is exceeded, the alteration of the volume and figure of the body is no longer proportional to the force producing it, but increases as the ultimate strength of the material is approached, a permanent change takes place, and when the force is removed the body will not quite assume its former volume and figure; this is called a *set.*

These principles are of great importance in considering the subject of the stiffness of beams.

To illustrate the above by a common example, if we should take a perfect timber beam, 10 feet long, and supported at both ends, and place upon it, at the centre, a weight that would cause a deflection of 1/8 of an inch, we would find that to produce a deflection of 1/4 of an inch, we should require a weight twice as large and, up to a certain point, the deflections would be directly proportional to the weight; but after a time we would reach a point where the deflections would increase faster than the weights, and the beam would be found to be a little bent, or to have a *set.* Beams should never be loaded sufficiently to produce a set.

MODULUS OF ELASTICITY.

That there may be a standard by which to compare the elasticity of different materials, engineers have taken as the unit of elasticity the number of pounds that would be required to stretch or shorten a bar, one unit square, by an amount equal to its original length, provided that the law of perfect

*Rankine's "Applied Mechanics," p. 272.

elasticity would hold good for so great a range. This unit is called the *Modulus of Elasticity*, and is often denoted by E. It is determined by either extending or compressing a piece of the given material, noting the extension or compression produced, and substituting it in a formula, for E, deduced by the aid of the higher mathematics.

The Modulus of Elasticity of the differentt woods and of iron, is required to determine the stiffness of beams and the strength of long columns. Table I. gives the average values for the woods in common use and also for iron.

TABLE I.—VALUES OF E, OR MODULUS OF ELASTICITY IN POUNDS, PER SQUARE INCH.

	Lbs.		Lbs.
Cast-iron	15,960,000	White oak	1,620,000
Wrought-iron	24,000,000	Yellow pine	1,800,000*
Steel	31,000,000	White pine	1,388,000*
White ash	1,080,000	Spruce	1,600,000
Locust	2,046,000		

*Determined by experiments made by the writer.

MANNER IN WHICH PIECES MAY BE STRAINED.

The laws of the resistance of materials depend on the manner in which the pieces are strained, and in building construction may be divided into five kinds.

First, When the force tends to pull the piece asunder in the direction of its length, or the *resistance to tension.*

Second, When the force tends to make one part slide on the other (like a pair of shears), either longitudinally or transversely, or the *resistance to shearing.*

Third, When the force tends to compress the body in the direction of its length, or the *resistance to compression.*

Fourth, When the force tends to break the piece across, or the *resistance to cross-breaking.*

Fifth, When the force tends to bend the piece, but is not sufficient to break it, or the *resistance to deflection.*

We will consider the ability of materials to resist these different kinds of strains in the above order.

TENACITY, OR RESISTANCE TO TENSION.

By the tenacity of a body is meant its strength to resist tension in the direction of its length.

It is evident that the strength of a piece to resist tension, depends upon the tenacity of its fibres, and hence must be proportional to the number of those fibres, or to the area of cross section. This is also shown to be true by experiments.

The tenacity of bodies per square inch of cross-section, has been found by suspending vertically a piece of known dimensions, and hanging weights to the lower end until it breaks, and from the data thus obtained find what the tenacity was per square inch of the area pulled apart.

Table II. gives the average values for iron and the woods used in construction, as determined by the most reliable experiments.

TABLE II.—RESISTANCE OF MATERIALS TO TENSION.

Kind of Material.	Tenacity in lbs. per square inch. T.	Kind of Material.	Tenacity in lbs. per square inch. T.
Cast iron	16,000	Hemlock	12,000
Wrought iron	60,000	Hickory	20,700
Steel	88,000	Maple	15,400
Ash	17,207	Oak, white	18,000
Beech	14,600	Georgia pine	16,000
Birch	15,000	Norway pine	7,300
Cedar	11,400	White pine	12,280
Chestnut	10,500	Spruce	18,000
Elm	13,240	Walnut	8,130
Fir	12,000		

Knowing the tenacity of one square inch of the material all we have to do to determine the tenacity of a piece of any

size is to multiply the area of its cross-section, in square inches, by the number in the table opposite the name of the material. But this would give the weight that would just break the piece, and as what we wish is the safe load, we must divide the result by a factor of safety. Most engineers advise using a factor of safety of five for a dead load, although the New York City and also the Boston Building Laws require a factor of six.

Then we have, as a rule,

For a rectangular bar—

$$\text{Safe load} = \frac{\text{breadth} \times \text{depth} \times T}{5}; \quad . \quad . \quad (1)$$

For a round bar—

$$\text{Safe load} = \frac{.7854 \times \text{diameter squared} \times T}{5}; \quad . \quad (2)$$

T = tenacity of material per square inch.

EXAMPLE: What is the safe load for a tie bar of White Pine 6×6 inches?

$$\text{Safe load} = \frac{6 \times 6 \times 12{,}280}{5} = 88{,}416 \text{ lbs.}$$

If the size of the bar is desired, we have—

$$\text{the breadth} = \frac{5 \times \text{load}}{\text{depth} \times T}; \dots\dots\dots\dots (3)$$

$$\text{diameter squared} = \frac{5 \times \text{load}}{.7854 \times T}; \dots\dots\dots (4)$$

EXAMPLE: It is desired to suspend 20,000 lbs. from a round rod of wrought-iron, what shall be the diameter of the rod, to carry the weight in safety?

Ans. $$\text{diameter squared} = \frac{5 \times 20{,}000}{.7854 \times 60{,}000} = 2.12.$$

The square root of this is 1.5, or $1\frac{1}{2}$ inches nearly. Therefore, the diameter of the rod should be $1\frac{1}{2}$ inches.

Table III. gives the safe loads for wrought-iron rods, using a factor of safety of 6, as required by the New York Building Laws.

TABLE III.—TABLE OF THE SAFE TENSILE STRENGTHS OF ROUND WROUGHT-IRON RODS, $\frac{1}{8}$ TO 4 INCHES IN DIAMETER, AND THE WEIGHTS PER FOOT, THE SAFE STRENGTH BEING TAKEN AT 10,000 LBS. PER SQUARE INCH.

Diameter in Inches.	Weights per foot.	Safe Strengths in lbs.	Diameter in Inches.	Weights per foot.	Safe Strengths in lbs.
$\frac{1}{8}$	.041	123	$\frac{1}{8}$	11.99	35,460
$\frac{1}{4}$	.165	491	$\frac{1}{4}$	13.44	39,760
$\frac{3}{8}$	.373	1,104	$\frac{3}{8}$	14.98	44,300
$\frac{1}{2}$	.663	1,963	$\frac{1}{2}$	16.69	49,080
$\frac{5}{8}$	1.04	3,068	$\frac{5}{8}$	18.29	54,110
$\frac{3}{4}$	1.49	4,418	$\frac{3}{4}$	20.08	59,390
$\frac{7}{8}$	2.03	6,013	$\frac{7}{8}$	21.94	64,910
1	2.05	7,854	3	23.89	70,680
$\frac{1}{8}$	3.36	9,940	$\frac{1}{8}$	25.93	76,690
$\frac{1}{4}$	4.17	12,227	$\frac{1}{4}$	28.04	82,950
$\frac{3}{8}$	5.02	14,840	$\frac{3}{8}$	30.24	89,460
$\frac{1}{2}$	5.97	17,670	$\frac{1}{2}$	32.512	96,210
$\frac{5}{8}$	7.01	20,730	$\frac{5}{8}$	34.89	103,200
$\frac{3}{4}$	8.13	24,050	$\frac{3}{4}$	37.33	110,440
$\frac{7}{8}$	9.33	27,610	$\frac{7}{8}$	39.86	117,930
2	10.62	31,410	4	42.46	125,660

Rods of wrought-iron are generally used in construction, with screws at the ends for nuts.

When this is the case, the rod should be enlarged at the ends, so that the threads of the screws may be cut without lessening the diameter of the rod. If this is not done, and the screw is cut into the rod without enlarging the end, one quarter should be subtracted from the strength found in the table.

Wrought-iron is about three times as strong to resist tensile strains as cast-iron; and as cast iron is liable to air holes,

internal strains from unequal contraction in cooling, and other concealed defects, reducing its effective area for tension, wrought-iron should therefore be used for tensile strains, whenever practicable.

RESISTANCE TO SHEARING.

By shearing is meant the pushing of one part of a piece by the other, as the two parts of a pair of shears move on each other.

The resistance of a piece to shearing, like its resistance to tension, is directly proportional to the area sheared. Hence, using 5 as a factor of safety, we have the rule for the safe weight, or force—

$$W = \frac{\text{area to be sheared} \times S}{5} \quad \ldots\ldots\ldots\ldots\ldots (5)$$

S being the resistance of one square inch of the material to shearing. A piece of timber may be sheared either longi-

TABLE IV.—SHOWING THE RESISTANCE OF MATERIALS TO SHEARING; BOTH LONGITUDINALLY AND TRANSVERSELY; OR, THE VALUES OF S.

Materials.	Values of S.	
	Longitudinally.	Transversely.
	lbs.	lbs.
Cast-iron	....	27,700
Wrought-iron	....	50,000
Steel	....	63,746
White ash	....	1,400
Beech	....	5,200
Birch	....	5,600
Hemlock	540	2,700
Locust	1,180	7,000
White oak	780	4,400
White pine	490	2,750
Yellow pine	510	5,700
Spruce	470	4,000
Black walnut	....	2,000

tudinally or transversely, and as the resistance is not the same in both cases, the value of S will be different; and hence, in substituting values for S, we must distinguish whether the force tends to shear the piece longitudinally (lengthwise), or transversely (across).

Table IV. gives the values of S for the most common materials employed in architectural construction.

There are but few cases in architectural construction in which the resistance to shearing has to be provided for. The one most frequently met with is at the end of a tie-beam, as in Fig. 1.

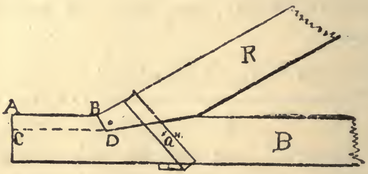

Fig. 1.

The rafter R exerts a thrust which tends to push or shear off the piece, A B C D, and the area of the section at C D should offer enough resistance to keep the rafter in place. This area is equal to C D times the breadth of the tie-beam, and as the breadth is fixed, we have to determine the length, C D. If we let H denote the horizontal thrust of the rafter, then, by a simple deduction from Rule 5, we have the rule—

$$\text{Length of C D in inches} = \frac{5 \times H}{\text{breadth of beam} \times S}, \quad ..(6)$$

S, in this case, being the resistance to shearing longitudinally.

Example: The horizontal thrust of a rafter is 20,000 lbs., the tie-beam is of yellow pine, and is ten inches wide, how far should the beam extend beyond the point D?

Answer: In this case H = 20,000 lbs., and from Table IV. we find that S = 510,

$$\text{then C D} = \frac{5 \times 20{,}000}{10 \times 510} \text{ or nearly 20 inches.}$$

Practically, a large part of the thrust is generally taken up by an iron bolt or strap, passed through or over the foot of the rafter and tie-beam, as at A. When this is done, the rod or strap should be as obliquely inclined to the beam as is possible, and whenever it can be done, a strap should be used in preference to a rod, as the rod cuts into the wood, and thus weakens it.

Another common case, in which the resistance to shearing has to be provided for, is in the case of iron pins and wooden tree-nails.

If we have three bars fastened together by a pin, and each pulling in the direction indicated by the arrows in Fig. 2, they will tend to shear off the pin at the sections "*a*" "*a*."

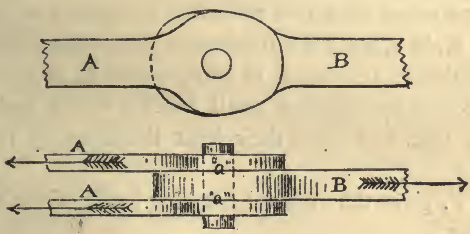

Fig. 2.

If the pull exerted by the tie, B, be denoted by H, then each section of the pin will have to resist one-half H, as there are two sections to resist the whole. Then from Rule 5 we deduct the following—

Diameter of wooden pin in inches = a square root of

$$\frac{5 \times H}{1.5708 \times S} \cdots\cdots\cdots\cdots\cdots\cdots (7)$$

Diameter of wrought iron pin in inches = a square root of

$$\frac{H}{15708} \cdots\cdots\cdots\cdots\cdots\cdots (8)$$

In Rule 7, S is the resistance to shearing transversely.

EXAMPLE: Suppose the bar, B, is pulling with a force of 141,372 lbs., what should be the diameter of an iron pin to resist it?

Answer: Diameter of square root of $\frac{141,372}{15,708} =$

square root of $9 = 3$ inches.

These are about the only two cases in which rupture by shearing is liable to take place in architectural constructions, and as any other cases that are liable to occur can be calculated by Rule 5, we will not consider the subject further.

The ultimate resistance to compression of any given material is found by crushing small blocks, whose heights are not more than four times their least thickness, of the given material.

Table V. gives the ultimate crushing loads of the materials in building.

The strength of the materials given in the following table may vary as much as one-third part more or less than the average value given. The stones in the table are supposed to be *on bed*, and the height to be not more than four times the least side. Of the strength of rubble masonry, Professor Rankine states that "the resistance of *good coursed rubble*

masonry to crushing is about four tenths of that of single blocks of the stone it is built with. The resistance of *common rubble* to crushing is not much greater than that of the mortar which it contains."*

TABLE V.—SHOWING THE AVERAGE ULTIMATE CRUSHING LOADS, IN LBS. PER SQUARE INCH, FOR BUILDING MATERIALS.

Materials.	Crushing Weight in lbs. per square inch = C.	Materials	Crushing Weight in lbs., per square inch = C.
STONES, ETC.		Wrought-iron ..	36,000
Bricks..............	500 to 6,000	Steel	114,000
Brickwork, common.	500 to 800	WOODS.	
Concrete (1 part lime, 3 parts gravel, 3 weeks old)........	600	White ash......	8,200
Granites and syenites	11,000	Beech	8,500
Limestones and marbles...............	10,000	Birch...........	11,600
Mortar, common	120 to 240	Cedar..........	5,860
Portland cement.....	1,000 to 5,900	Hemlock.......	5,400
Sandstones, fit for building..........	5,400	Locust.........	9,000
METALS.		White oak......	6,660
Cast-iron	80,000	Georgia pine....	8,000
		White pine.....	5,000
		Pitch pine.....	6,800
		Spruce.........	6,820
		Black walnut...	5,690

Stones generally commence to crack or split under about one half of their crushing load. In practice, stone nor brickwork should be trusted with more than one-sixth to one-tenth of the crushing load, varying between these two limits with the quality of the stone and work.

CRUSHING HEIGHT OF BRICK AND STONE.

If we assume the weight of brickwork to be 112 pounds per cubic foot, and that it would crush under 72,000 pounds per square foot, then a vertical uniform column 640 feet high would crush at its base under its own weight.

* "Civil Engineering," p. 387.

Average sandstones at 145 pounds per cubic foot would require a column 5,362 feet high to crush it; and average granite at 165 pounds per cubic foot would require a column 9,600 feet high. The Merchants' shot-tower at Baltimore is 246 feet high; and its base sustains six and a half tons (of 2,240 pounds) per square foot. The base of the granite pier of Saltash Bridge (by Brunel) of solid masonry to the height of 96 feet, and supporting the ends of two iron spans of 455 feet each, sustains nine and a half tons per square foot. The highest pier of Rocquefavour stone aqueduct, Marseilles, is 305 feet, and sustains a pressure at the base of thirteen and a half tons per square foot.*

The *woods* for which the values are given are supposed to be perfect, well-seasoned pieces of timber. Wet timber is only about one-half as strong to resist compression as dry timber, and this fact should be taken into account when using green timber. The values obtained for the crushing strength per square inch of cast-iron vary greatly with the kind and make of the iron.

The crushing strength of thin castings, according to Mr. Hodgkinson, is greater than that of thick castings.

STRENGTH OF PILLARS AND COLUMNS.

The figures given in Table V. are the crushing loads per square inch of small blocks of the given material, but it is not in small blocks that the pieces subject to a compressive force are generally found in buildings and structures. Hence we must find a method of calculating the crushing loads of long pieces, or of finding the *strength of pillars and columns*. It has been found from experiments that the crushing load per square inch of a post of any given material decreases as the ratio of the length to the least thickness increases. It is,

*Trautwine's "Engineers' Pocket-Book," p. 175.

therefore, found necessary to divide columns and pillars into different classes, according to the manner in which they break.

PILLARS AND COLUMNS DIVIDED INTO THREE CLASSES, ACCORDING TO LENGTH.

The greater part of our knowledge of the laws of the resistance of columns of different length, in proportion to their diameter, is derived from the able experiments of Mr. Eaton Hodgkinson, aided by the liberality of Sir William Fairbairn, the late Mr. Stephenson, and the Royal Society of England.

From these experiments, Mr. Hodgkinson found that the manner in which columns fail depends very largely upon their length, and he therefore divided them into three classes, according to their length, and these classes have since been adopted by nearly, if not all, engineers and architects. These classes are:

1st. *Short Pillars*, whose length, compared with their diameter, is so small that they fail by actual crushing of the material, and not by flexure.

2d. *Long Columns*, whose length is so great that they fail by bending, like beams subject to a transverse strain, and whose breaking weight is very much less than that required to crush small blocks of the same material.

3d. *Medium Columns*, whose length is such that although they deflect, yet the breaking weight is a very considerable part of that required to crush small blocks. This class includes all columns which are intermediate in length between those of the first two classes, and they may be said to fail partly by bending and partly by crushing.*

SHORT COLUMNS,

which include columns and pillars of *cast-iron*, whose lengths do not exceed *five* times their least thickness; columns and

*Stoney's "Theory of Strains," p. 249.

pillars of *wrought-iron* and *wood*, whose lengths do not exceed *eight* times their least thickness or diameter; stone pillars and blocks of ordinary dimensions.

It has been found that for columns and pillars within the above limits, the crushing load per square inch is the same as that for small blocks. Hence the crushing load is directly as the area of cross-section, and the rule for finding the safe load is similar to that for tension, *i.e.*:

$$\text{Safe load for wood} = \frac{\text{area of cross-section} \times C}{5} \quad \ldots\ldots\ldots(9)$$

$$\text{Safe load for wrought-iron} = \frac{\text{area of cross-section} \times C}{4} \quad \ldots(10)$$

$$\text{Safe load for cast-iron} = \frac{\text{area of cross-section} \times C}{6} \quad \ldots\ldots(11)$$

The letter C stands for the crushing loads per square inch of the given material, and its values are given in Table V. The numbers in the denominator are factors of safety.

EXAMPLE: What is the safe load of a pillar of white pine, whose length is five feet, and which is ten inches square?

Answer: Here the ratio of length to breadth is 60 : 10 or 6 : 1, hence it is a short pillar.

$$\text{Then, safe load} = \frac{10 \times 10 \times 5{,}000}{5} = 100{,}000 \text{ lbs.}$$

If it is required to find the *dimensions* of a pillar or column to sustain a given load, we have the rules:

For solid rectangular or square pillars—

$$\text{Breadth} = \frac{\text{factor of safety} \times \text{load}}{\text{depth} \times C} \quad \ldots\ldots\ldots\ldots\ldots\ldots(12)$$

For solid cylindrical columns—

$$\text{Diameter squared} = \frac{\text{factor of safety} \times \text{load}}{\cdot 7854 \times C} \quad \ldots\ldots\ldots\ldots (13)$$

For hollow cylindrical columns—

$$\text{External diameter squared} = \frac{\text{factor of safety} \times \text{load}}{\cdot 7854 \times C} + \text{internal diameter squared} \ldots\ldots\ldots\ldots (14)$$

And for any form of cross-section—

$$\text{Area of cross-section} = \frac{\text{factor of safety} \times \text{load}}{C} \quad \ldots\ldots\ldots (15)$$

It will be remembered that the factors of safety are—5 for wood, 6 for cast-iron, and 4 for wrought-iron, for pillars and columns of this class.

N.B.—Where the word breadth or depth is used, it is always supposed to be in inches.

EXAMPLE: What should be the external diameter of a hollow cylindrical column of cast-iron, three feet six inches long, to safely support a load of 400,000 lbs.?

Answer: As the column is so short and the load quite considerable, it will probably be a short column, and hence we will calculate it by means of formula 14. Then—

$$\text{External diameter squared} = \frac{6 \times 400{,}000}{\cdot 7854 \times C} + \left\{ \begin{array}{l} \text{internal} \\ \text{diameter} \\ \text{squared} \end{array} \right.$$

$= 38.32 +$ internal diameter squared.

If the columns were solid, the external diameter would be the square root of 38.32, or about 6.2; but as the column is to be hollow, the diameter will be much larger, and we will assume 5 for the internal diameter; then—

External diameter squared $= 38.32 + 25 = 63.32$; external diameter $= 8$ inches nearly.

This would give the thickness of the metal $= \frac{1}{2}$ of $8 - 5 = 1\frac{1}{2}$ inches. If we had taken the internal diameter at 6, we should have had the external diameter $= 8.6$ inches, which would give a thickness of metal of 1.3 inches.

Taking the external diameter at 8 and the internal at 5, we should have the area of cross-section $= .7854\ (8^2 - 5^2) = 30.6$ square inches.

LONG COLUMNS,

which include columns and pillars of *wood* whose lengths exceed thirty times their diameter; columns and pillars of *cast-iron*, whose lengths exceed thirty-five times their diameter; columns and pillars of *wrought-iron*, whose lengths exceed sixty times their diameter, and columns and pillars of *steel* whose lengths exceed eighty times their diameter.

When a load is applied to the top of a long pillar or column, if the resultant of that load should not exactly traverse the axis of the column (which is rarely the case), the column will bend, and if the load is sufficiently great, it will cause the pillar, or column, to bend until it breaks, just as a beam breaks. But unlike a beam, the column has a force pushing on the ends, instead of at the middle, and hence its strength must be calculated by a different method. Of course, in a column we do not wish to put on load enough to cause the column to bend, and the problem is, therefore, to find the load that will just begin to bend the column, and then by using a factor of safety we can make the column as strong as we please.

The problem to determine the actual strain which would just begin to bend the column is quite a difficult one. It has, however, been investigated by Euler, Dr. Young, M.

Girod, and many others, but with contradictory results, and a complete theory is yet wanting.

The numerous formulas that we now have on the subject may be divided into two classes, viz., those derived from mathematical investigation, and depending only indirectly upon experiments; and that class which are derived almost entirely from experimental data. Unfortunately, neither of these classes furnish a correct solution of the problem.

Theoretical Formulas.—The following formulas deduced from the theoretical formulas of Weisbach, DeVolson, Wood, and others, are probably as reliable as any theoretical formulas that we have at the present time:

For solid square or rectangular pillars—

$$\text{Safe load} = \frac{\text{E} \times \text{breadth cubed} \times \text{depth}}{1750 \times \text{length squared}} \quad \ldots\ldots\ldots\ldots\ldots (16)$$

For hollow square or rectangular pillars—

$$\text{Safe load} = \frac{\text{E} \times (\text{B}^3 \times \text{D} - b^3 \times d)}{1750 \times \text{length squared}} \quad \ldots\ldots\ldots\ldots\ldots (17)$$

(B = external breadth of pillar; D external depth of pillar; b internal breadth of pillar; d internal depth of pillar, all in inches).

For solid cylindrical columns—

$$\text{Safe load} = \frac{\text{E} \times \text{diameter}^4}{2970 \times \text{length squared}} \quad \ldots\ldots\ldots\ldots\ldots (18)$$

For hollow cylindrical columns—

$$\text{Safe load} = \frac{\text{E} \times (\text{D}^4 - d^4)}{2970 \times \text{length squared}} \quad \ldots\ldots\ldots\ldots\ldots (19)$$

(D = external diameter; *d* internal diameter).

It will be remembered that the letter E stands for the *Modulus of Elasticity*, and its value for any material can be found from Table I. The lengths in the above formulas are to be taken in *feet.*

N.B.—The factor of safety used is 10 for all materials.

EXAMPLE: What is the greatest load that a wrought-iron cylindrical column, whose diameter is five inches, and whose length thirty feet, will bear with safety?

Answer: For wrought-iron $E = 24{,}000{,}000$, and substituting in formula 18, we have—

$$\text{Safe load} = \frac{24{,}000{,}000 \times 5 \times 5 \times 5 \times 5}{2970 \times 30 \times 30} = 5611 \text{ lbs.}$$

The above formulas apply to pillars and columns of any material, and are, perhaps, as reliable as any.

Practical Formulas, derived from data obtained by experimental research.

From the data obtained from his experiments, Mr. Hodgkinson deduced the following formulas for the strength of *long cast-iron cylindrical columns:*

For solid columns with flat ends—

$$\text{Safe load} = \frac{9890 \times D^{3.6}}{L^{1.7}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (20)$$

For hollow columns with flat ends—

$$\text{Safe load} = \frac{9923 \times (D^{3.6} - d^{3.6})}{L^{1.7}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (21)$$

in which $D =$ the external diameter; d the internal diameter, and L the length in feet.

The diameter and length can be raised to the required power by obtaining the logarithm of the diameter or length,

multiplying it by the respective power, and then seeking the number corresponding to the logarithm; or it may be found by means of tables calculated for that purpose, such as those given by Mr. Trautwine in his "Pocket-Book for Engineers." But these formulas are, at the best, in a very inconvenient form for use. Mr. Hodgkinson, Mr. Tredgold, Dr. Young, and several others have given us formulas for *long timber* pillars, but as they all give different results, and as it is impossible to decide which one is correct, or if all are wrong, we have not deemed it best to give either of them, but if any reader has a long timber column he wishes to calculate, he can find the safe load by formula 16 or 18.

If it is desired to find the *breaking load* of any long column or pillar, multiply the safe load by 10, as that is the factor of safety employed in all the formulas for long columns.

HODGKINSON'S CONCLUSIONS ON THE STRENGTH OF LONG PILLARS.

The following are some of the principal conclusions drawn by Mr. Hodgkinson from his experiments on the strength of long pillars:

1. In all long pillars of the same dimensions, the resistance to flexure of those with fixed (or flat) ends, is about three times that of pillars with rounded ends.

2. The strength of pillars with one end round and one flat, is a mean between the strength of a pillar with both ends flat, and of one with both ends round.

3. The strength of a long pillar with flat ends, is equal to that of a pillar of half the length, with the round ends.

4. The preceding properties exist in pillars of either cast or wrought-iron, steel, or wood, and apply only to pillars whose length is so great in proportion to their diameter, or least lateral dimension, that the breaking weight of the pillar

is only a very small part of the crushing weight of the material.

5. Disks on the ends of cast-iron pillars add but little to the strength of flat-ended pillars.

6. The strength of solid cast-iron pillars is increased from one-eighth to one-seventh, by enlarging the diameter at the middle of the pillar.

7. Long pillars irregularly fixed, so that the pressure does not act in the direction of the axis, lose from two-thirds to four-fifths of their strength.

Mr. Hodgkinson also states that "of rectangular pillars of *timber*, it was proved experimentally that the pillar of greatest strength, where the length and quantity of material are the same, is a square."

Of solid round, square, and triangular cast-iron pillars, the triangular pillar appears to be the strongest, and the cylindrical one next to it. But since the shape of the triangular pillar will generally prohibit its use, it would appear that the round pillar is the most economical form of solid cast-iron pillar.

MEDIUM COLUMNS

include all those pillars and columns in which the ratio of the length to the diameter, or least thickness, is between that of the two classes already considered.

Most of the pillars and columns in common use come under this head.

Before proceeding further, we would caution the reader not to get the ABSOLUTE length mixed up with the *relative* length.

Thus, a pillar 30 feet long and 4 inches diameter, is longer in comparison with its diameter than a column 40 feet long and 10 inches in diameter.

In the former case the ratio of length to diameter is as

360 : 4, or 90 : 1. In the latter case the ratio is as 480 : 10, or 48 : 1.

In medium pillars it is considered that part of the load tends to deflect or bend the pillar, and that the remaining part acts directly to crush the pillar.

The form of the formulas in this class has been derived from theoretical investigation, but each formula involves at least two constants, derived from experimental research.

Timber Pillars.—Tredgold's formula for the strength of medium timber pillars has for a long time been considered the most reliable of any known rule; but a few years ago Mr. Charles Shaler Smith, C.E., of Baltimore, prepared a formula for the breaking loads of white and yellow pine rectangular pillars, differing only from Mr. Tredgold's in the value of a constant, which appears to agree more nearly with the results of the few experiments that have been made on this class of pillars. And as this formula has been adopted by many eminent engineers, we have decided to adopt it in the place of Mr. Tredgold's formula.

This formula is:

For square or rectangular timber pillars—

$$\text{Safe loads in lbs.} = \frac{C \times \text{area of cross section}}{6\left[1 + \left(\dfrac{\text{sq. of length in in.,}}{\text{sq. of breadth in in.}} \times .004\right)\right]} \qquad (22)$$

By the "breadth" is meant either side of a square, or the least side of a rectangle. C represents the crushing force per square inch, and is given for different materials in Table V. Mr. Smith's constant of .004, in the denominator, is based on experiments made by himself on pillars of white and yellow pine, but if the constant is true for those woods, it should also be true for any woods.

EXAMPLE. – What is the safe load of a white pine pillar, 12 x 14 inches, and 30 feet, or 360 inches, long?

Ans.: Safe load $= \dfrac{5{,}000 \times 168}{6\left[1 + \left(\dfrac{129{,}600}{144} \times .004\right)\right]}$

$= 30{,}434$ lbs.

For medium *iron* columns the formulas most generally adopted are those derived by Mr. Lewis Gordon from Mr. Hodgkinson's experiments. For the more common cases these formulas are as follows:

For solid cylindrical columns of cast-iron—

$$\text{Safe load} = \frac{\text{Metal area} \times 80{,}000}{6\left[1 + \left(\dfrac{\text{sq. of length in ins.}}{266 \times \text{sq. of diam. in ins.}}\right)\right]} \quad \ldots.(23)$$

For solid cylindrical columns of wrought iron—

$$\text{Safe load} = \frac{\text{Metal area} \times 36{,}000}{4\left(1 + \dfrac{\text{sq. of length in ins.}}{3{,}000 \times \text{sq. of diam in ins.}}\right)} \quad ..(24)$$

For hollow cylindrical columns of cast-iron—

$$\text{Safe load} = \frac{\text{Metal area} \times 80{,}000}{6\left(1 + \dfrac{\text{sq. of length in ins.}}{400 \times \text{sq. of diam. in ins.}}\right)} \quad \ldots(25)$$

For hollow cylindrical columns of wrought-iron—

$$\text{Safe load} = \frac{\text{Metal area} \times 36{,}000}{4\left(1 + \dfrac{\text{sq. of length in ins.}}{4{,}500 \times \text{sq. of diam. in ins.}}\right)} \quad ..(26$$

For hollow or solid rectangular pillars of cast-iron—

$$\text{Safe load} = \frac{\text{Metal area} \times 80{,}000}{6\left(1 + \dfrac{\text{sq. of length in ins.}}{500 \times \text{sq. of least side in ins.}}\right)} \quad (27)$$

For solid rectangular pillars of wrought-iron—

$$\text{Safe load} = \frac{\text{Metal area} \times 36{,}000}{4\left(1 + \dfrac{\text{sq. of length in ins.}}{3{,}000 \times \text{sq. of least side in ins.}}\right)} \quad (28)$$

For hollow rectangular pillars of wrought-iron—

$$\text{Safe load} = \frac{\text{Metal area} \times 36{,}000}{4\left(1 + \dfrac{\text{sq. of length in ins.}}{6{,}000 \times \text{sq. of least side in ins.}}\right)} \quad (29)$$

For I-shaped section of wrought-iron—

$$\text{Safe load} = \frac{A \times 36{,}000}{4\left(1 + \dfrac{l^2}{3{,}000\, B^2 \frac{a}{a+b}}\right)} \quad (30)$$

where l = length of strut in inches: B = breadth of flange in inches; *a*, area of both flanges, and *b*, area of web.

In formulas 22–30 inclusive, the number outside the parenthesis in the denominator, is the factor of safety, and should be omitted when the *breaking weight* is desired. These factors are those used by the engineer of the Union Iron Mills, Pittsburg, Pa., in calculating the strength of their columns, and are the ones adopted by our best engineers. Where the *diameter* is mentioned, the external diameter is always meant, unless expressly stated to be otherwise.

EXAMPLES.—To make the application of the above formulas perfectly clear, we will now give a few examples.

I. What load will a hollow cylindrical column of cast-iron, 6 inches external diameter, 10 feet long, and 1 inch thick, support with safety?

Answer: Formula 25 is the formula that is to be used in this case, and substituting the given dimensions, we have—

$$\text{Safe load} = \frac{15.7 \times 80{,}000}{6\left(1 + \dfrac{14{,}400}{400 \times 36}\right)} = 104{,}666 \text{ lbs.}$$

II. What would be the maximum safe load of a hollow rectangular wrought-iron pillar, 6×12 inches, 1 inch thick, and 10 feet long?

Answer: In this case we must use Formula 29, which gives—

$$\text{Safe load} = \frac{32 \times 36{,}000}{4\left(1 + \dfrac{14{,}400}{6{,}000 \times 36}\right)} = 269{,}984 \text{ lbs.}$$

III. What would be the safe compressive strain for a "Union Mills" light I-beam 10 feet long, used as a strut?

Answer: in this case we must use Formula 30, and for the values of a, b, and B, we must look in a hand-book published by the company.

Looking in the "Book of Sections," we find $a = 5.8$ square inches, $b = 3.2$ square inches, and $B = 4.3$ inches, l, of course, $= 120$ inches. Substituting these values in Formula 30, we have—

$$\text{Safe load} = \frac{9 \times 36{,}00}{4\left(1 + \dfrac{14{,}400}{3{,}000 \times 18.49 \dfrac{5.8}{5.8 + 3.2}}\right)}$$

$$= \frac{324{,}000}{4\left(1 + \frac{14{,}400}{35{,}747}\right)} = 57{,}857 \text{ lbs.}$$

There are several other forms of iron struts, such as angle irons, channel irons, T-irons, etc., but these are so seldom used in buildings, that we have not felt warranted to give them here.

Comparative Value of Cast and Wrought-Iron for Pillars.—When iron was first introduced into building construction, cast-iron was the only kind used, but with the improvements for rolling wrought-iron, and thereby lessening the cost of wrought-iron beams, columns, etc., wrought-iron has been more and more introduced, until now it is very extensively used. Owing to the more fibrous, compact, and homogeneous character of wrought-iron, it can be more safely relied upon, and thus we need not use as large a factor of safety for wrought as for cast-iron. For columns under 15 diameters height, and not subjected to any vibration, cast-iron, on account of its cheapness, is perhaps preferable to wrought-iron, but in almost all other cases wrought-iron is to be preferred, and especially where the columns have to support a load which causes them to vibrate. In railway bridges and iron roofs, wrought-iron is now taking the place of cast-iron almost altogether.

Hollow Columns, calculated by the above formulas, should not be cast with heavy projecting mouldings round the top or bottom. It is obvious that these are weak, and would break off under a much less load than would be required to crush the column.

When such projecting ornaments are deemed necessary, they should be cast separately, and be attached to a prolongation of the shaft by iron pins or rivets. Ordinarily, it is

better to adopt a more simple base and cap which can be cast in one piece with the pillar, without weakening it.

TABLES.

By an inspection of the formulas for medium columns, it will be seen that, all other things being the same, the strength per square inch of cross-section of any column depends only upon the ratio of the length to the diameter or least thickness. Thus, a column 15 feet long and 10 inches diameter, would carry the same load per square inch as a similar column 9 feet long and 6 inches diameter, both having the ratio of length to diameter, as 18 to 1.

Owing to this fact, tables can be prepared giving the safe load per square inch for columns having their ratio of length to diameter, within the given limits for medium columns. Working on this principle, the writer has calculated Tables VI., VII., and VIII., giving the loads per square inch for wooden pillars, and hollow wrought and cast-iron pillars and columns.

These tables have been calculated with the utmost care and carefully compared with others of a similar nature, so that we feel safe in saying that they can be perfectly relied upon.

To show the application of these tables we will take two examples.

I. What is the safe load for a pitch-pine pillar 10 inches square and 15 feet long?

Ans. Here the length divided by breadth = 18. Looking opposite 18, and in the column for pitch-pine, in Table VI., we find the safe load to be 494 lbs. per square inch of cross-section. Multiplying this by area of cross-section, 100, we have 49,400 as the safe load for the pillar.

II. What is the safe load of a hollow rectangular wrought-iron pillar 10 × 12 inches, 1 inch thick, and 20 feet long?

Ans. Here the ratio of length to least breadth is 24, and looking opposite 24, and in the fifth column of Table VIII., we find the safe load per square inch of cross-section to be 8,211 lbs. The total area of cross-section is $10 \times 12 - 8 \times 10 = 40$ square inches. Hence the safe load for the pillar is $40 \times 8{,}211$ lbs. $= 328{,}440$.

TABLE VI.—STRENGTH OF RECTANGULAR TIMBER PILLARS.

(*Calculated by Formula* 22.)

Length Divided by Breadth.	Safe Load in Pounds, per Square Inch. (Calculated with a Factor of Safety of 6.)			
$\frac{l}{B}$	White Pine.	Pitch Pine.	White Oak.	Spruce.
8	663	902	884	905
9	629	856	838	858
10	595	809	793	812
11	562	764	748	766
12	529	718	704	721
13	497	676	662	678
14	467	635	622	637
15	438	596	584	598
16	411	560	548	561
17	386	526	515	527
18	363	494	483	495
19	341	464	454	465
20	320	436	427	437
21	301	410	401	411
22	284	386	377	387
23	267	363	356	364
24	252	343	335	344
25	238	324	317	324
26	226	306	299	306
27	213	289	283	290
28	201	274	268	274
29	191	260	254	260
30	181	246	241	247
31	172	234	229	234
32	163	222	217	223
33	155	211	207	212
34	148	201	197	202
35	141	191	188	192

TABLE VII.*—STRENGTH OF HOLLOW CYLINDRICAL OR RECTANGULAR CAST-IRON PILLARS.

(*Calculated by Formulas* 25 *and* 27.)

Length Divided by External Breadth or Diameter.	Breaking Weight in Pounds, per Square Inch.		Safe Load in Pounds, per Square Inch.	
	Cylindrical.	Rectangular.	Cylindrical.	Rectangular.
5	75,294	76,190	12,549	12,698
6	73,395	74,627	12,232	12,438
7	71,269	72,859	11,878	12,143
8	68,965	70,922	11,494	11,820
9	66,528	68,846	11,088	11,474
10	64,000	66,666	10,666	11,111
11	61,420	64,412	10,236	10,735
12	58,823	62,111	9,804	10,352
13	56,239	59,790	9,373	9,965
14	53,859	57,471	8,976	9,578
15	51,200	55,172	8,533	9,195
16	48,780	52,910	8,130	8,817
17	46,444	50,697	7,741	8,449
18	44,198	48,543	7,366	8,090
19	42,050	46,457	7,008	7,743
20	40,000	44,444	6,666	7,407
21	38,050	42,508	6,341	7,085
22	36,200	40,650	6,033	6,775
23	34,455	38,872	5,742	6,479
24	32,787	37,174	5,464	6,195
25	31,219	35,555	5,203	5,926
26	29,741	34,014	4,957	5,669
27	28,343	32,547	4,724	5,423
28	27,027	31,152	4,504	5,192
29	25,785	29,828	4,297	4,971
30	24,615	25,571	4,102	4,761
31	23,512	27,310	3,918	4,818
32	22,472	26,246	3,745	4,374
33	21,491	25,172	3,581	4,195
34	20,565	24,154	3,427	4,026
35	19,692	23,188	3,282	3,864

*Tables VII. and VIII. were first published in the *American Architect* for December 13, 1879.

TABLE VIII.—STRENGTH OF HOLLOW CYDINDRICAL OR RECTANGULAR WROUGHT-IRON PILLARS.

(*Calculated by Formulas* 26 *and* 29).

Length Divided by External Breadth or Diameter.	Breaking Weight in Pounds. per Square Inch.		Safe Load in Pounds, per Square Inch.	
	Cylindrical.	Rectangular.	Cylindrical.	Rectangular.
8	35,495	35,620	8,874	8,905
9	35,369	35,520	8,842	8,880
10	35,217	35,410	8,804	8,852
11	35,057	35,288	8,764	8,822
12	34,883	35,156	8,721	8,789
13	34,697	35,013	8,674	8,753
14	34,497	34,861	8,624	8,715
15	34,286	34,698	8,571	8,674
16	34,062	34,527	8,515	8,632
17	33,827	34,346	8,457	8,586
18	33,582	34,155	8,395	8,539
19	33,327	33,957	8,332	8,489
20	33,061	33,750	8,265	8,437
21	32,787	33,535	8,197	8,384
22	32,504	33,313	8,126	8,328
23	32,213	33,083	8,053	8,271
24	31,915	32,846	7,979	8,211
25	31,610	32,604	7,902	8,151
26	31,298	32,354	7,824	8,088
27	30,981	32,100	7,770	8,025
28	30,659	31,840	7,665	7,960
29	30,331	31,574	7,583	7,893
30	30,000	31,304	7,500	7,826
31	29,665	31,030	7,416	7,757
32	29,326	30,758	7,331	7,689
33	28,985	30,469	7,246	7,677
34	28,642	30,184	7,160	7,546
35	28,297	29,896	7,077	7,476
36	27,950	29,605	6,987	7,401
37	27,603	29,312	6,901	7,328
38	27,254	29,017	6,813	7,254
39	26,906	28,719	6,726	7,179
40	26,557	28,421	6,639	7,105
41	26,209	28,121	6,552	7,030
42	26,862	27,821	6,465	6,955
43	25,515	27,511	6,378	6,877
44	25,171	27,218	6,293	6,804
45	24,827	26,916	6,206	6,729

TABLE VIII. (*Continued*).

Length Divided by External Breadth or Diameter.	Breaking Weight in Pounds. per Square Inch.		Safe Load in Pounds, per Square Inch.	
	Cylindrical.	Rectangular.	Cylindrical.	Rectangular.
46	24,486	26,614	6,121	6,553
47	24,146	26,312	6,036	6,578
48	23,809	26,011	5,952	6,503
49	23,475	25,711	5,869	6,428
50	23,143	25,412	5,786	6,353
51	22,814	25,113	5,703	6,278
52	22,488	24,816	5,622	6,204
53	22,164	24,520	5,541	6,130
54	21,845	24,226	5,461	6,056
55	21,528	23,934	5,382	5,983
56	21,215	23,642	5,304	5,910
57	20,906	23,354	5,226	5,838
58	20,600	23,067	5,150	5,767
59	20,298	22,782	5,074	5,695
60	20,000	22,500	5,000	5,625

STRENGTH OF BEAMS.

The fourth kind of resistance which we have to discuss is the resistance to *transverse strain* or *cross-breaking*. Pieces of wood, or other materials, which have to resist transverse strain, are called beams, and as the amount of resistance they offer depends upon their strength, the real subject which we have to discuss is the *strength of beams*. In almost all works on the strength of materials, this subject is considered mathematically; that is, the rules and formulas are derived by mathematical investigation. This method is a very pretty one, and is not difficult for those who are familiar with the higher mathematics; but the writer believes that the greater part of the rules can be derived solely from a consideration of the results of experiments that have been made on the strength of beams of different spans and dimensions; and he proposes to endeavor to derive them in this way.

Fortunately, theory and experiment agree perfectly on this subject, so that as long as we work upon correct principles the final results should be the same in either case. We shall first take up the subject of beams with a rectangular or square cross-section, and afterward those of other forms of cross-section.

Formulas for Rectangular Beams. Before proceeding further, we will define a few terms which we shall be obliged to use. When we say that the end of a beam is *supported*, we mean that it is just laid on top of a pier or other support, and not fastened in any manner. When it is said to be fixed, it is supposed to be fastened so that it cannot spring up—the end of a beam is generally fixed when it is securely imbedded in a wall. By the *breadth* of a beam we mean the width of the top or bottom side. By the *depth* is meant the height of the beam as it rests on its supports. The *span* of a beam means the distance between supports, and the term length is often used to denote the same thing, unless otherwise stated.

Derivation of Formulas. The first step in this process is to determine the weight, which applied at the centre of a beam of the given material, *one inch square*, *supported at both ends*, and having a *span of one foot*, will just break the beam. This quantity is frequently called the *co-efficient* of *centre breaking loads*, and often the *constant* for *beams*.

In this article we shall denote this value by A. Table IX. gives the values of A, as derived by taking an average of the values given by many different authorities.

It has been found, from experiments, that if the beam were two inches wide instead of one, it would hold just twice as much; and if three inches wide, it would hold three times as much, and so on. That is, the strength is *directly* as the *breadth.* Then if the breaking weight of a beam one inch square and one foot long be equal to A, the breaking weight

of any other beam of the same material, one inch deep and one foot long, would = breadth $\times$ A.

It has also been found that if the breadth and span remain the same, but the depth be changed to two inches instead of one, it will hold *four times* as much; and if it be three inches it will hold nine times as much. Or, the strength increases directly as the *square of the depth.*

Then if the breaking weight of a beam one foot span and one inch deep = breadth $\times$ A, the breaking centre weight of a beam one foot span, but of any breadth and depth = breadth $\times$ square of depth $\times$ A. Furthermore, if the breadth and depth of the unit beam remain unchanged, but the length be doubled, the breaking load will be decreased one-half; if it be increased to three feet the breaking weight will be one-third, and if to four feet the breaking weight will be one-fourth, and so on. Or, the strength of a beam is *inversely as the length.* Then we have the formula for a rectangular beam, supported at both ends and loaded at the centre as follows:

$$\text{Breaking weight} = \frac{\text{breadth} \times \text{square of depth} \times \text{A}}{\text{length in feet.}} \quad (31)$$

From experiments on beams, it has been found that when the load on a beam is equally distributed over its length, the beam will hold just twice as much as it would if the load were concentrated and applied at one point at the centre. Hence, to obtain the breaking weight of a beam supported at both ends, and loaded with a uniformly distributed load, we should multiply the last member of equation, 31, by 2.

It has further been found, from experiments, that a beam supported at both ends and loaded with a concentrated load at the centre, will sustain just *four* times as much weight as a beam of the same length having one end firmly fixed in a wall, and the load applied at the extreme end.

From these known facts, and from equation 31, we have the following formulas for rectangular beams:

BEAMS SUPPORTED AT BOTH ENDS.

For concentrated load at the centre:

$$\text{Safe load} = \frac{\text{breadth} \times \text{square of depth} \times \text{A}}{\text{span in feet} \times \text{S.}} \ldots\ldots\ldots\ldots (32)$$

$$\text{or breadth} = \frac{\text{S} \times \text{load} \times \text{span in feet}}{\text{square of depth} \times \text{A.}} \ldots\ldots\ldots\ldots (33)$$

For uniformly distributed load:

$$\text{Safe load} = \frac{2 \times \text{breadth} \times \text{square of depth} \times \text{A}}{\text{span in feet} \times \text{S.}} \ldots\ldots (34)$$

$$\text{or breadth} = \frac{\text{S} \times \text{span in feet} \times \text{load}}{2 \times \text{square of depth} \times \text{A.}} \ldots\ldots\ldots\ldots (35)$$

For load applied at a point other than the centre, *m* and *n* being the segments into which the beam is divided:

$$\text{Safe load} = \frac{\text{breadth} \times \text{square of depth} \times \text{span} \times \text{A}}{4 \times \text{S} \times m \times n.} \ldots (36)$$

$$\text{or breadth} = \frac{4 \times \text{S} \times \text{load} \times m \times n}{\text{square of depth} \times \text{span} \times \text{A.}} \ldots\ldots\ldots\ldots (37)$$

BEAMS FIXED AT ONE END.

For concentrated load at extreme end:

$$\text{Safe load} = \frac{\text{breadth} \times \text{square of depth} \times \text{A}}{4 \times \text{length in feet} \times \text{S.}} \ldots\ldots\ldots (38)$$

$$\text{or breadth} = \frac{4 \times \text{S} \times \text{load} \times \text{length in feet}}{\text{square of depth} \times \text{A.}} \ldots\ldots\ldots\ldots (39)$$

For a uniformly distributed load:

$$\text{Safe load} = \frac{\text{breadth} \times \text{square of depth} \times A}{2 \times \text{length in feet} \times S.} \quad \ldots\ldots\ldots(40)$$

$$\text{or breadth} = \frac{S \times \text{load} \times \text{length in feet} \times 2}{\text{square of depth} \times A.} \quad \ldots\ldots\ldots\ldots(41)$$

In the above formulas S represents the *factor of safety*, and its value in different cases is as follows: For ordinary cases $S = 5$ for wooden beams, 3 for wrought-iron beams, and 4 for cast-iron beams. For wooden beams in roofs, $S = 6$; for wooden beams in floors of theatres, lecture-halls, etc., 8; in floors of stores, 6.

The values of the constant A are given in Table IX.

TABLE IX.—VALUES OF A, THE COEFFICIENT OF CENTRE-BREAKING LOADS.

Materials.	Value of A in lbs.	Materials.	Values of A in lbs.
Cast-iron.............	1,850	American white oak..	580
Wrought-iron	2,700	" white pine..	460
Steel	4,500	" yellow pine	725
		" spruce......	548
American ash........	590		
" red beech..	580	Blue stone flagging,	
" yellow birch	534	Hudson River	125
" white cedar.	255	Granite, average.....	100
" elm........	340	Limestone, "	90
New England fir	367	Marble, "	100
Hemlock	380	Sandstone, "	50
American red oak	560	Slate, "	300

EXAMPLE I. What is the greatest load that a yellow pine beam 8 x 10 inches, supported on two piers 15 feet apart, will carry with safety, if the load is uniformly distributed?

Answer: Formula 34 is the one that covers this case, and, substituting the known values for the terms, we have:

$$\text{Safe load} = \frac{2 \times 8 \times 100 \times 725}{5 \times 15} = 15{,}466 \text{ lbs.}$$

EXAMPLE II. What shall be the dimensions of a spruce beam, having a clear span of 10 feet, that shall be able to support a concentrated load of 12,000 lbs., suspended from the beam at a point 4 feet from one end?

Answer: In this case Formula 36 is the one to use, and m and n equal 4 and 6. In order to obtain the breadth we must assume the depth, which we will take at 12 inches.

$$\text{Then the breadth} = \frac{4 \times 5 \times 12{,}000 \times 4 \times 6}{144 \times .0 \times 548} = 7\tfrac{1}{2} \text{ inches.}$$

EXAMPLE III. A beam of white pine 10 inches square has one end securely fixed in a wall, and the other projects out from the wall 6 feet. What is the greatest load that can with safety be suspended from the extreme end?

Answer: This is the case of a beam fixed at one end and loaded at the extreme end, and is to be solved by means of Formula 38.

$$\text{Then safe load} = \frac{10 \times 100 \times 460}{4 \times 6 \times 5} = 3{,}833 \text{ lbs.}$$

From an inspection of Formulas 32, 34, 36, 38 and 40, we see that the relative strength of rectangular beams in different cases is as follows:

Beam supported at both ends, and loaded with a uniformly distributed load	1
Beam supported at both ends and loaded at the centre	½
Beam fixed at one end, and loaded with a uniformly distributed load	¼
Beam fixed at one end, and loaded at the other	⅛

Also the following can be shown to be true:

Beam firmly fixed at both ends, and loaded at the centre 1

Beam fixed at both ends, and loaded with distributed load .... $1\frac{1}{2}$

These facts are also true of a uniform beam of any form of cross-section.

When a square beam is supported on its edge, instead of on its side—that is, has its diagonal vertical—it will bear about 7-10 as great a breaking load.

A Cylindrical Beam is only 1-1.7 as strong as a square beam, whose side is equal to the diameter of the circle. Hence, to find the load for a cylindrical beam, first find the proper load for the corresponding square beam, and then divide it by 1.7.

Strength of Inclined Beams. For inclined beams the same formulas apply as for horizontal beams, except that the length is the horizontal projection of the beam, or the horizontal distance from the foot of the beam to a plumb line dropped from its upper end.

EXAMPLE: What is the safe load for a beam of white pine 3 inches broad, 6 inches deep, and 10 feet long, uniformly loaded, and having one end 6 feet above the other?

Answer: In this case the horizontal length is 8 feet, and

$$\text{the safe load} = \frac{2 \times 3 \times 36 \times 460}{5 \times 8} = 2{,}484 \text{ lbs.}$$

Weight of the Beam Itself to be taken into Account.—The formulas we have given for the strength of beams, do not take into account the weight of the beam itself, and hence the safe load of the formulas includes both the external load and the weight of the material in the beam. In small wooden beams,

the weight of the beam is generally so small, compared with the external load, that it need not be taken into account. But in larger wooden beams, and in metal and stone beams, the weight of the beam should be subtracted from the safe load, if the load is distributed, and if the load is applied at the centre one-half the weight of the beam should be subtracted.

To obtain the weight of the beam, it is necessary to know the weight of one cubic foot of the material. Table X. gives the weight of one cubic foot of the most common kinds of wood and stone, and also of iron and steel. It is made up from a table given by Mr. R. G. Hatfield, in his excellent work on "Transverse Strains."

TABLE X.—SHOWING THE WEIGHT IN POUNDS OF ONE CUBIC FOOT OF DIFFERENT KINDS OF BUILDING MATERIALS.

Material.	Weight per Cubic Foot.	Material.	Weight per Cubic Foot
STONES.	lbs.	WOODS.	lbs.
Bath stone..........	139	Ash.	49
Béton coignet........	129	Beech..............	46
Blue stone..........	160	Birch................	42
Granite, average.....	165	Cedar................	31
Limestone, "	169	Elm..................	46
Marble, "	170	Hemlock...........	26
Sandstone, "	144	Oak, red............	51
Slate................	159	Oak, white.........	50
		Pine, white........	28
METALS.		Pine, yellow.........	33
Cast-iron............	454	Spruce...............	30
Wrought-iron.......	480		
Steel................	489		

Rule for Finding the Weight of a Rectangular Beam.—Weight in pounds = breadth × depth in inches × length in feet × weight per cubic foot ÷ 144....................(42)

Tables Showing the Strength of Beams one inch wide and of different depths and spans can be easily calculated, so that by the aid of one of these tables all we have to do to find the strength of any beam, is to take from the table for beams of that material the safe load for a beam of the same depth and span, and then multiply this load by the breadth of the given beam. In this article space will not permit us to give such a table for more than one material, and we have choosen white pine as the material most used in construction. This table can be used, however, for yellow pine and spruce beams by adding to the members in the table one-half for yellow pine and one-fifth for spruce.

EXAMPLE. What is the safe load of a white pine beam 3 x 6 inches, supported at both ends, and loaded uniformly over its whole length, the clear span being 12 feet?

Answer: From Table XI. we find the safe load of a beam 1 x 6 inches, and span of 12 feet, loaded at the centre, to be = 276 pounds. Multiplying this by the breadth of the beam, 3, we have the safe load = 828 pounds, if it were loaded at the centre, but as it is loaded with a distributed load it will be twice as strong, and hence the safe load will be 1656 pounds.

The Bearing of the ends of a beam on a wall beyond a certain amount does not strengthen the beam any. In general, a beam should have a bearing of 4 inches, though if the beam be very short the bearing may be less.

Continuous Beams. When a long beam is laid over several points of support, a very common occurrence in building, the strength of the intermediate parts is nearly doubled, or twice as much as when cut into small lengths, hence the advantage of using long timbers for girders.*

*Tredgold's "Carpentry," by Hurst, pp. 66.

TABLE XI.—SHOWING THE SAFE LOAD IN POUNDS OF WHITE PINE BEAMS, LOADED AT THE CENTRE, ONE INCH WIDE, AND FOR DEPTHS AND SPANS VARYING FROM 2 TO 16 INCHES, AND FROM 4 TO 29 FEET.

(*Calculated with a Factor of Safety of* 5).

Depth in Inches.	Span in Feet.				
	4	6	8	10	12
2	92	61	46	37	30
3	207	136	103	82	69
4	368	245	184	147	122
5	575	383	287	230	191
6	828	552	414	331	276
7	1,127	751	563	450	375
8	1,472	981	736	591	491
9	1,863	1,242	931	745	621
10	2,300	1,533	1,150	920	766
11	2,783	1,855	1,391	1,113	927
12	3,312	2,208	1,656	1,325	1,104
13	3,887	2,591	1,943	1,555	1,295
14	4,508	3,005	2,254	1,803	1,503
15	5,175	3,450	2,587	2,070	1,725
16	5,888	3,925	2,944	5,889	1,962

Depth in Inches.	Span in Feet.				
	14	16	18	20	22
2	26	23	20	18	16
3	59	51	45	41	38
4	105	92	81	73	67
5	164	143	127	115	104
6	236	207	184	165	150
7	322	282	250	225	205
8	420	368	327	295	268
9	532	466	414	372	339
10	657	575	511	460	418
11	795	695	618	556	506
12	946	828	736	662	602
13	1,110	971	863	777	707
14	1,288	1,127	1,002	901	820
15	1,478	1,294	1,150	1,035	941
16	1,682	1,472	1,308	2,944	1,070

STRENGTH OF IRON BEAMS.

When it is required to support very heavy loads, it is often found to be cheaper and better to use iron beams instead of wood. Formerly cast-iron beams were the only iron beams used; but since the improvements in the process of rolling iron, wrought-iron beams have almost wholly superseded those of cast-iron. Still, as cast-iron beams are sometimes used, it is well to know how to calculate their strength.

CAST-IRON BEAMS. Most of our knowledge of the strength of cast-iron beams is derived from the experiments of Mr. Eaton Hodgkinson. From these experiments he found that the form of cross-section of a beam which will resist the greatest transverse strain is that in which the bottom flange contains six times as much metal as the top flange.

(Perhaps it would be well to say that the usual form of iron beams is that of the letter I. The top and bottom parts are called the *flanges*, and the vertical part the *web*).

When cast-iron beams are subjected to very light strains, the areas of the two flanges ought to be nearly equal. As in practice it is usual to submit beams to strains less than the ultimate load, and yet beyond a slight strain, it is found that when the flanges are as 1 to 4 we have a proportion which approximates very nearly the requirements of practice. The thickness of the three parts—web, top flange and bottom flange—may, with advantage, be made in proportion as 5, 6, and 8.

If made in this proportion, the width of the top flange will be equal to one-third of that of the bottom flange. As the result of his experiments, Mr. Hodgkinson gives the following rule for the breaking weight at the centre for a cast-iron beam of the above form :

$$\text{Breaking load in tons} = \frac{\dfrac{\text{Area of bot. flange}}{\text{in sq. ins.}} \times \text{depth in ins.} \times 2.166}{\text{clear span in feet.}} \quad \ldots(43)$$

Cast-iron beams should always be tested by a load equal to that which they are designed to carry.

ROLLED-IRON BEAMS.

Owing to the deceptive character of cast-iron, and the much greater resistance offered to transverse strain by wrought iron, compound wrought-iron plate beams and girders were formerly used to support very heavy loads. These beams became so popular that, to supply the demand, iron manufacturers made rolls similar to those for making railroad iron, by which they were enabled to furnish beams rolled out in one piece with all the best features of the plate beam, and which could be much more readily and cheaply made. Owing to the large cost of the rolls, only a very few sizes were at first made, but as the demand increased new sizes were added, until now we have them in great variety—from 3 to 15 inches high.

Rolled-iron beams are of the shape of the letter I, and have their top and bottom flanges of the same size. The vertical part is the web, and is generally considered to resist the tendency of the load to shear the beam.

Formulas. We cannot deduce a rule for rolled-iron beams in the manner in which we derived the formulas for wooden beams, both on account of lack of experiments and the peculiar shape of the beam. The formulas for this class of beams must be derived by mathematical demonstration, requiring a considerable degree of proficiency in the higher mathematics. While not attempting to give the precise method by which the formulas are derived, we will, however,

undertake to indicate it sufficiently, so that the method can be compared with those given by more advanced works on the subject.

The fundamental formula, from which all others must be derived, is obtained by placing the *bending moment* equal to the *moment* of *resistance*, and may be expressed by the formula:

$$M = \frac{R\,I}{y} \dots\dots\dots\dots\dots\dots\dots\dots (44)$$

y in beams of regular cross-section being equal to one-half of the depth. The letter M denotes the bending moment, the letter R the modulus of rupture, obtained from experiments, and the letter I the moment of inertia.

The values of the letters I and y vary only with the size of the beam; while the value of the letter M varies only with the span, the mode of support, and the manner of loading.

The value of R is generally taken at 42,000 lbs. for a *breaking load*, and for a *safe load* ⅓ of this, or 14,000 lbs. per square inch.

Substituting the correct values of the letters in Formula 44, we have the formula for *safe load of rolled-iron beam, loaded at the centre and supported at both ends:*

$$\text{Safe load} = \frac{7000}{9\,L \times d} \times (b \times d^3 - b_1 \times d_1^3) \dots\dots\dots\dots (45)$$

in which $L =$ span in feet, $d =$ the whole depth of beam, $b =$ width of flange, $b_1 =$ the width of flange minus average thickness of the web, and d_1 the whole depth minus twice the average thickness of the flange.

The value of I, employed in Formula 45, is obtained by considering the flanges to be perfect rectangles, with square corners; but there is a value of I, obtained by considering the area of the flange as concentrated on a horizontal line

passing through its centre of gravity, which is very much easier of application. Substituting this latter value of I in place of the former value, and we have the safe load, for the case above described, as follows:

$$\text{Safe load at centre} = \frac{14{,}000 \times d}{3 \times L} \times \left(\frac{a_1}{6} + a \times \frac{d_1^2}{d^2} \right) \ldots .(46)$$

in which d = whole depth of beam, L = span of beam in feet, a_1 = area of the web, a = area of one flange, and d_1 = effective depth in inches between centres of gravity of flanges.

If we put this into a rule, it would read as follows:

RULE.—Multiply the square of the effective depth by the area of one flange, and divide by the square of the whole depth of the beam; to this quotient add one-sixth of the area of the web, and multiply the sum by 14,000, multiplied by the whole depth, and divided by 3 times the span in feet.

Formula 46 is the one employed by the Union Iron Mills Co. for calculating the strength of their beams. For a distributed load, multiply the safe load at the centre by two.

In using iron beams, of course it is a great deal cheaper to use a pattern already manufactured, rather than to have a special beam made to order. There are three prominent companies which manufacture iron beams, and each of these companies have handbooks containing full information concerning the different forms of iron beams and bars which they manufacture.

These companies are the *New Jersey Steel and Iron Co.*, of Trenton, N. J., who manufacture the *Trenton* beams; *Carnegie Brothers & Co.*, of Pittsburgh, Pa., who manufacture the *Union Iron Mills* beams; and the *Phœnix Iron Co.*, of Philadelphia, who manufacture the *Phœnix* beams. The handbooks issued by these companies contain the moment of

inertia of each beam, and when we have this value we can substitute it directly in the formula:

$$\left.\begin{matrix}\text{Safe load at}\\ \text{centre in lbs.}\end{matrix}\right\} = \frac{28{,}000 \times \text{moment of inertia}}{3 \times \text{span in ft.} \times \text{depth of beam}} \quad (47)$$

N. B.—In formulas 45, 46, 47, a factor of safety of 3 has been adopted.

We will now compare the results of these three formulas, by calculating the strength of a rolled-iron beam by each method:

EXAMPLE. What is the largest load that a heavy 10-inch I-beam, of the Union Iron Mills pattern, will bear with safety at the centre, the distance between supports being 10 feet? We will first solve it by Formula 45. In this case $L = 10$, $d = 10$, $b = 4.5$, $b_1 = 4$, and $d_1 = 8.38$.

The values of the last three quantities are obtained from the book of sections published by Carnegie Bros. & Co.

Substituting these values in equation 45, we have:

$$\text{Safe load at centre} = \frac{7000}{9 \times 10 \times 10} \times (4.5 \times 1000 - 4 \times 588.5) = 16{,}690 \text{ lbs.}$$

We will now solve it by Formula 46. From the same book of sections we find $a_1 = 5.1$, $a = 3.15$, $d_1 = 9.19$ inches.

Substituting these values with those of d and L in equation 46, we have:

$$\text{Safe load at centre} = \frac{14{,}000 \times 10}{3 \times 10} \times \left(\frac{5.1}{6} + \frac{3.15 \times 9.19^2}{100}\right) = 16{,}380 \text{ lbs.}$$

We also find from the same source the value of the mo-

ment of inertia of this beam to be 175.5. Substituting this value in Equation 47, we have:

$$\text{Safe load at centre} = \frac{28{,}000 \times 175.5}{3 \times 10 \times 10} = 16{,}380 \text{ lbs.}$$

Comparing results, we find that:

By	Formula	45,	safe	load	= 16,690 lbs.
"	"	46,	"	"	= 16,380 "
"	"	47,	"	"	= 16,380 "

Formulas 46 and 47 give the same result, because they have the same moment of inertia. These results do not differ much from that of Formula 45, and what error there is, is on the safe side.

For the benefit of those who have not the handbooks mentioned, we give Tables XII. and XIII., which are made up from tables published by the Union Iron Mills Co., and those published by the New Jersey Steel and Iron Co.

The number designating the size of the beam is its depth in inches. Thus a 10-inch beam is 10 inches deep. The values for the safe distributed load given in column II. are for *one foot* of span, and to get the load for any span it is only necessary to divide the load for a span of *one foot* by the given span *in feet*. To get the safe load if applied at the centre of the beam, divide the safe distributed load by 2. In designing an iron beam, the weight of the beam itself should be subtracted from the calculated load, to give the *true working load*, if the load is distributed; and if applied at the centre, one-half of the weight of the beam should be subtracted from the safe load.

Iron beams should have at least four inches bearing on a wall, pier, or other support. We will illustrate the application of Tables XII. and XIII. by two examples.

TABLE XII.—SHOWING THE STRENGTH, WEIGHT AND DIMENSIONS OF UNION IRON MILLS ROLLED I-BEAMS.

Designation of Beam.	I.	II.	III.	IV.	V.	VI.	VII.
	Weight per yard in lbs.	Safe distributed load for 1 foot of span in lbs.	Moment of Inertia.	Width of flanges in Inches.	Areas in sq. ins. of one flange, a.	Areas in sq. ins. of Web, $a_{,}$.	Effective depth in ins, $d_{,}$.
15 inch Heavy.	201	848,000	682	5.5	5.175	9.75	13.91
15 " Light..	150	658,000	528.7	5.0	4.2	6.60	14.06
12 " Heavy.	180	582,000	373.7	5.15	4.32	9.36	11.00
12 " Light..	126	416,000	267	4.5	4.18	6.24	11.19
10½ " Heavy.	105	308,000	173.8	4.63	2.625	5.25	9.84
10½ " Light..	94.5	276,000	154.9	4.53	2.58	4.30	9.84
10 " Heavy.	114	328,000	175.5	4.5	3.15	5.10	9.19
10 " Light..	90	278,000	149.0	4.3	2.90	3.20	9.25
9 " Heavy.	90	246,000	118.7	4.34	2.925	3.15	8.25
9 " Light..	71¼	206,000	100	4.06	2.395	2.34	8.34
8 " Heavy.	81	198,000	84.8	4.	2.61	2.88	7.28
8 " Light..	66	164,000	70.4	3.75	2.185	2.24	7.37
7 " Heavy.	60	132,000	49.2	3.63	2.09	1.82	6.37
7 " Light..	54	124,000	47.0	3.56	2.075	1.26	6.37
6 " Heavy.	48	90,400	29.2	3.38	1.685	1.44	5.44
6 " Light..	40.5	76,600	24.7	3.22	1.425	1.20	5.50
5 " Heavy.	36	51,400	13.8	2.88	0.925	1.75	4.62
5 " Light..	30	43,800	11.8	2.75	0.925	1.15	4.62
4 " Heavy.	30	32,600	7.0	2.63	0.72	1.56	3.67
4 " Light..	24	28,000	6.0	2.50	0.72	.96	3.67
3 " Heavy.	24	19,600	3.2	2.34	0.695	1.01	2.66
3 " Light..	21	18,200	2.9	2.25	0.69	.72	2.66

EXAMPLE 1. It is proposed to support the floor of a lecture hall by means of rolled-iron I-beams, resting upon piers 15 feet apart; what size beam will be required?

Ans.: If the beams are 15 feet span and 12 feet "on centres," they will each have to support a floor area of 180 square feet. The average weight of a wooden floor, including joists, etc., is about .0 lbs. per square foot. The load that is to come upon the floor should be taken at 120 lbs. per square foot, making the weight of the floor and its load 130 lbs. per square foot, giving a total load on each beam of 23,400 lbs.

Now, in order to find from the table the size of beam required to carry this load, we must multiply the total load by the span, which is the same thing as dividing the values in column II. by the span. $23{,}400 \times 15 = 351{,}000$; and looking in column II. of Tables XII. and XIII., we find that the beam carrying a safe load next above this is the 12-inch light "Union" beam, or the 10½-inch heavy Trenton beam. Therefore these must be the sizes required. The weight of the 12-inch beam will be $126 \times 5 = 630$ lbs., and of the 10½-inch beam $135 \times 5 = 675$ lbs.

TABLE XIII.—SHOWING THE STRENGTH, WEIGHT, AND DIMENSIONS OF TRENTON ROLLED I-BEAMS.

Designation of Beam.	I.	II.	III.	IV.	V.	VI.	VII.
	Weight per yard in lbs.	Safe distributed load in lbs., for 1 foot of span.	Moment of Inertia.	Width of flanges in inches.	Areas in sq. ins.		Effective depth in ins. $d_{\prime}$.
					of one flange, a.	of web, $a_{\prime}$.	
15 inch Heavy.	200	748,000	701.1	5¾	5.48	9.07	13.9
15 " Light..	150	551,000	523.5	5	3.73	7.59	14.0
12¼ " Heavy.	170	511,000	391.2	5½	4.69	7.39	11.1
12¼ " Light..	125	377,000	288.0	4.8	3.29	5.75	11.2
10½ " Heavy.	135	360,000	233.7	5	4.22	4.93	9.7
10½ " Light..	105	286,000	185.6	4½	3.26	3.93	9.84
9 " Extra..	125	268,000	150.8	4½	3.60	5.13	8.2
9 " Heavy.	85	189,000	106.5	4	2.43	3.46	8.25
9 " Light..	70	152,000	85.6	3½	1.92	2.70	8.34
8 " Heavy.	80	168,000	83.9	4½	2.53	2.96	7.28
8 " Light..	65	135,000	67.4	4	1.99	2.40	7.37
7 " 55 lbs.	55	101,000	44.3	3¾	1.70	2.10	6.40
6 " 120 "	120	172,000	64.9	5¼	4.04	3.75	5.00
6 " 90 "	90	132,000	49.8	5	2.85	3.00	5.00
6 " Heavy.	50	76,800	29.0	3½	1.56	1.80	5.44
6 " Light..	40	62,600	23.5	3	1.26	1.50	5.5
5 " Heavy.	40	49,100	15.4	3	1.17	1.56	4.62
5 " Light..	30	38,700	12.1	2¾	0.89	1.20	4.62
4 " Heavy.	37	36,800	9.2	3	1.21	1.25	3.67
4 " Light..	30	30,100	7.5	2¾	0.96	1.00	3.67
4 " ex. Light.	18	18,000	4.5	2	0.51	0.75	3.70

TABLE XIV.—SHOWING THE STRENGTH AND WEIGHT OF TRENTON AND UNION IRON MILLS ROLLED CHANNEL BARS.

Union Iron Mills.			Trenton.		
Designation of Bar.	I. Weight per yard in lbs.	II. Safe distributed load in lbs., for span of 1 foot.	Designation of Bar.	III. Weight per yard in lbs.	IV. Safe distributed load in lbs. for span of 1 foot.
12 inch Heavy..	150	388,000	15 inch Heavy.	190	625,000
12 " Medium	90	276,000	15 " Light..	120	401,000
10 " Heavy.	105	244,000	$12\frac{1}{4}$ " Heavy.	140	381,000
10 " Medium	69	186,000	$12\frac{1}{4}$ " Light..	85	238,000
9 " Heavy	90	185,600	$10\frac{1}{2}$ " Light..	60	134,750
9 " Medium	54	136,000	9 " Heavy.	70	146,000
8 " Heavy.	75	140,000	9 " Light..	50	104,000
8 " Medium	48	106,400	8 " Light.	45	88,950
7 " Heavy.	60	102,000	7 " Light..	36	62,000
7 " Medium	42	83,600	6 " Heavy.	45	58,300
6 " Heavy.	33	52,000	6 " Light..	33	45,700
5 " Heavy.	30	38,200	5 " ex. Light	19	22,800
			4 " ex. Light	$16\frac{1}{2}$	15,700
			3 " ex. Light	15	10,500

EXAMPLE 2. It is required to support a 16-inch brick wall, 30 feet high and 15 feet wide, containing six windows, three feet by six feet, by two rolled-iron I-beams; what must be their size?

Ans.: It is first necessary to find the cubic contents of the wall. If the wall were solid, with no windows, it would contain $1\frac{1}{3} \times 15 \times 30$, or 600 cubic feet of brick. But the six windows will contain $6 \times 1\frac{1}{3} \times 3 \times 6$, or 144 cubic feet; so that the total contents of the wall is $600 - 144$, or 456 cubic feet of brick. A cubic foot of brickwork weighs, on the average, 110 lbs., hence the weight of the wall will be 456×110 lbs., or 50,160 lbs. The load on each beam will therefore be 25,080 lbs. Multiplying this weight by the

span, we have 376,200 lbs., and looking in column II. of Tables XII. and XIII., we find that we shall need a 12-inch light "Union" beam, or a 12¼-inch light "Trenton" beam, to carry this load, and it will require two of these beams to support the wall. The weight of the 12-inch beam will be 5 × 126, or 630 lbs., and of the 12¼-inch beam, 125 × 5, or 625 lbs.

There are several other forms of iron bars that are occasionally used as beams, such as *channel bars*, *deck beams*, *angle irons*, etc., but these are not enough used in buildings to warrant us in taking the room to discuss them here. Table XIV. gives the safe loads of the "Union" and "Trenton" channel bars, as given in the handbooks published by their respective companies.

From the foregoing tables the strength of materials may be calculated for structures of considerable importance, and the results may be relied upon as nearly correct as it is possible to get them. Mr. Kidder has been very careful in calculating, arranging, and compiling these tables, and adapting them to American conditions.

Bricks and Brick Piers.

It has been thought that the following tests of the strength of bricks and brick piers, recently made by Mr. Kidder for the Massachusetts Mechanics' Association, would be of good service where brick work has to be provided for. The bricks tested were as follows:

*Three Philadelphia face-bricks.

Four New England pressed bricks. Four ordinary Cambridge (Mass.) bricks.

*From "American Architect and Building News."

Three bricks from Boston Terra-Cotta Company.

One brick of selenitic cement and coke.

One porous terra-cotta brick.

Two bricks of Selenitic cement and sand.

The specimens were tested in the government testing-machine at Watertown, Mass., and great care was exercised to make the tests as perfect as possible. As the parallel plates between which the bricks were crushed are fixed in one position, it is necessary that the specimen tested should have perfectly parallel faces. The bricks which were tested were rubbed on a revolving bed until the top and bottom faces were perfectly true and parallel, or as nearly so as it was possible to make them. The preparation of the bricks in this way required a great deal of time and expense, the latter amounting to two or three dollars for a single brick, in many cases.

PHILADELPHIA FACE-BRICK: These bricks were furnished by Waldo Brothers, 57 Kilby St., Boston. They were very perfect in form, but quite soft, being the softest clay brick tested.

First brick measured 8.23" x 4.1" x 2.32" thick. It was crushed flatwise, as were all of the bricks. The brick was first subjected to a pressure of 50,000 lbs., which was gradually increased. The brick commenced to crack under a pressure of 145,000 lbs., or 4,303 lbs. to the square inch. The cracks first appeared on one edge, and then the other edges soon cracked. Before the brick was finally crushed it was cracked badly, and several pieces had fallen from the outside. *The brick failed under* 204,300 *lbs., or* 6,062 *lbs.* per *square inch.*

Second brick measured 8.3" x 2.3" thick. This brick commenced to crack under 113,000 lbs., or 3,400 lbs. to the square inch, *and failed under* 193,600 *lbs., or* 5,831 *lbs. per square inch.*

Third brick measured 4.1" x 8.3" x 2.25" thick. It commenced to crack under 98,000 lbs. pressure (2,879 lbs. per square inch), and was badly cracked under 154,000 lbs. pressure. *Net strength* 199,500 *lbs., or* 5,860 *lbs. to the square inch.*

COMMON BRICK (from Mr. M. W. Sand's brick-yard, Cambridge, Mass.): These bricks represent good Eastern brick, and were very hard, containing considerable flint. It was so difficult to rub down the faces of these bricks to parallel surfaces that only one whole brick was prepared, and the remaining specimens were half bricks.

First brick measured 7.88" x 3.27" x 1.97" thick; cracked slightly under a pressure of 150,000 lbs., but the cracking did not increase until after the pressure had reached 200,000 lbs. *The net strength of the brick was* 333,500 *lbs., or* 12,940 *lbs. per square inch.*

First half-brick measured 3.25" x 3.35" x 2.02" thick. Commenced to crack under 40,000 lbs. pressure (3,670 lbs. per square inch). *Net strength* 107,000 *lbs., or* 9,825 *lbs. to the square inch.* The brick cracked most on the sides which had been the outside edges of the whole brick.

Second half-brick measured 3.25" x 3.9" x 2.1" thick. Cracks first appeared under 43,000 lbs. pressure (3,393 lbs. per square inch). *Net strength* 148,000 *lbs., or* 11,681 *lbs. to the square inch.*

Third half-brick measured 3.4" x 3.95" x 2.05" thick. This brick did not fit between the plates of the machine very perfectly. Commenced to crack under 51,000 lbs. pressure (3,797 lbs. per square inch). *Net strength* 192,000 *lbs., or* 14,296 *lbs. to the square inch.*

NEW ENGLAND PRESSED BRICK, made in Danvers, Mass.: These samples were selected from a lot of brick exhibited at the recent fair of the Association by the New England Pressed Brick Company.

These bricks being made under hydraulic pressure are extremely hard (so hard that it was almost impossible to cut them with stone-cutters' chisels), and are very regular in shape. All the specimens of this kind of bricks were half-bricks cut from whole ones.

First brick measured 3.5″ x 3.7″ x 1.98″ thick. Cracks were first observed while the brick was under a pressure of 50,000 lbs. (3,862 lbs. per square inch). *Net strength* 133,000 *lbs., or* 10,270 *lbs. per square inch.*

It was observed, while testing this brick, that while the edge face of the brick that had been the end of the whole brick cracked and fell off in pieces, the face which had been at the centre of the brick remained intact.

Second brick measured 3.75″ x 3.52″ x 2.1″ thick. First crack appeared when the brick was under a pressure of 108,000 lbs., or 8,180 lbs. per square inch. *Ultimate strength* 178,600 lbs., *being* 13,530 *lbs. to the square inch.* This brick did not crack very badly.

Third brick measured 3.5″ x 3.8″ x 1.91″ thick. First crack appeared when the pressure reached 33,000 lbs. (2,480 lbs. per square inch), *and the brick failed under* 174,000 *lbs., or* 13,082 *lbs. to the square inch.* Very much of the outside of the brick scaled off before the brick was crushed.

Fourth brick measured 3.8″ x 3.54″ x 2.12″ thick. It commenced to crack under 61,000 lbs. pressure (4,535 lbs. per square inch), *and was crushed under a pressure of* 176,000 *lbs., or* 13,085 *lbs. per square inch.*

BRICK MANUFACTURED BY THE BOSTON TERRA-COTTA CO. (Messrs. Lewis & Lane, Proprietors): These bricks are made from finer clay than the common brick tested, and were more uniform in quality.

First brick. This brick was nearly in the form of a square, with one corner cut off; the brick measured 3.82″ x 3.78″ on

the long sides, and was 1.36″ thick. The area of the compressed surface was only 11.46 square inches. The brick did not fit between the plates of the machine very perfectly, so that it was necessary to use very thin brass packing. The brick cracked a little at one corner, under a pressure of 40,000 lbs., but this was owing to imperfectly fitting the machine, and the crack did not increase until the pressure reached 132,000 lbs., 11,518 lbs. per square inch. *Net strength of the brick,* 158,400 *lbs., or* 13,839 *lbs. per square inch.*

Second brick. This brick was shaped like an ordinary brick with one corner cut off, except that it had a slight depression in one face. This depression was filled with plaster-of-Paris, that being the best material at hand; the depression was not more than one-tenth of an inch. The brick had an area on its face of 25.6 square inches, and was 1.86″ thick. It commenced to crack when under a pressure of 220,000 lbs. (8,593 lbs. per square inch), *and was crushed under* 272,000 *lbs., or* 11,406 *lbs. to the square inch.*

Third brick. This brick was of the same shape as the previous brick, and the depression in its face was filled in the same way. It is very probable that the strength of these two bricks was lowered by the depression filled with plaster-of-Paris. The area of the face of the brick was 28.88 square inches, and it was 1.9″ thick. The brick commenced to crack while under a pressure of 3,530 lbs. per square inch. *Net strength* 253,000 *lbs.*, or 9,766 *lbs. to the square inch.*

The tensile strength of brick of this manufacture was determined, by testing 4 briquets of the usual form, to be about 520 lbs. to the square inch, being equal to that of the best Portland cement a year old.

Brick of Selenitic Cement and Sand: These bricks (furnished by the Patent Selenitic Cement Co., of Boston),

were exhibited at the recent fair of the Association. These brick are only dried, not baked, and are not very hard.

First brick measured 8.5" x 4.3" x 2.05" thick, and weighed $5\frac{1}{2}$ lbs. Owing to imperfect fitting it was necessary to use brass packing at two corners. The brick commenced to crack under a pressure of 656 lbs. per square inch, *and failed under* 56,600 *lbs., or* 1,548 *lbs. per square inch.*

Second brick measured 4.35" x 8.54" x 2.2" thick; commenced to crack under a pressure of 1,284 lbs. per square inch, *and was crushed under* 55,900 *lbs., or* 1,504 *lbs. per square inch.* Both of these bricks were so disintegrated by being crushed that they could be crumbled into a powder between the fingers.

BRICK OF SELENITIC CEMENT AND COKE: This is a fire-proof brick manufactured for the Patent Selenitic Cement Co. This brick measured 4.35" x 8.5" x 2.15" thick, and weighed 4 lbs., being both soft and light. It commenced to crack when under a pressure of 24,000 lbs. (650 lbs. per square inch), *and failed under* 47,700 *lbs., or* 1,290 *lbs. to the square inch.*

BRICK OF POROUS TERRA-COTTA (manufactured for fire-proofing, for Mr. E. S. Loring, under his patents): This brick is of a low grade of fire-clay, mixed with sawdust and burnt. The sawdust burning out leaves the brick very porous. The specimen tested measured 3.7" x 7.85" x 2.25" thick. It cracked at 9,000 lbs., and would stand no more pressure; hence, *its net strength was* 9,000 *lbs., or* 309 *lbs. to the square inch.*

The following table shows the strength of each brick tested, with the area of the face to which the pressure was applied, and the average strength of the different makes of bricks.

Name of Brick.	Area of Face in sq. ins.	Commenced to crack under lbs. per sq. in.	Net strength sq. in.
Philadelphia Face Brick	33.7	4,303	6,062
" " "	32.2	3,400	5,831
" " "	34.03	2,879	5,862
Average,		3,527	5,918
Cambridge Brick (Eastern).....	25.77	7,760	12,941
" " "	10.89	3,670	9,825
" " "	12.67	3,393	11,681
" " "	13.43	3,797	14,296
Average,		4,655	12,186
New England Pressed Brick....	12.95	3,862	10,270
" " "	13.2	8,180	13,530
" " "	13.30	2,480	13,082
" " "	13.45	4,535	13,085
Average,		4,764	12,490
Boston Terra-Cotta Co.'s Brick.	11.46	11,518	13,839
" " " "	25.60	8,593	11,406
" " " "	28.88	3,530	9,766
Average,		7,880	11,670
Selenitic Cement and Sand.....	36.55	656	1,548
" " "	37.15	1,284	1,504
Average,		970	1,526
Selenitic Cement and Coke.....	36.97	650	1,290
Porous Terra-Cotta............	29.04	309	309

Comparing the strength of the hard-burned brick, we see that the weakest is 9,766, while the strongest is 14,296 lbs. to the square inch.

Mr. Trautwine gives the strength of brick at from 777 lbs. to 4,662 lbs. per square inch, and the average strength as 2,720 lbs. per square inch.

Hence, in using the figures given by Mr. Trautwine for the strength of our common Eastern brick, we use a value which is at least one-third smaller than it should be.

The tests just described, being made on full-size bricks, selected at random, and with a very perfect testing-machine, are worthy of considerable confidence.

TESTS OF THE STRENGTH OF BRICK PIERS, LAID WITH VARIOUS MORTARS.

These tests were made for the purpose of testing the strength of brick piers laid up with different cement mortars, as compared with those laid up with ordinary mortar. The brick used in the piers were procured at M. W. Sands' brick-yard, Cambridge, Mass., and were good ordinary brick. They were from the same lot as the samples of common brick tested, as described.

The piers were 8" x 12", and nine courses, or about $22\frac{1}{2}$" high, excepting the first, which was but eight courses high.

They were built November 29, 1881, in one of the store-houses at the United States Arsenal in Watertown, Mass. In order to have the two ends of the piers perfectly parallel surfaces, a coat of about half an inch thick of pure Portland cement was put on the top of each pier, and the foot was grouted in the same cement.

March 3, 1882, three months and five days later, the tops of the piers were dressed to plane surfaces at right angles to the sides of the piers. On attempting to dress the lower ends of the piers, the cement grout peeled off, and it was necessary to remove it entirely and put on a layer of cement similar to that on the top of the piers. This was allowed to harden for one month and sixteen days, when the piers were tested. At that time the piers were four months and twenty-six days old. As the piers were built in cold weather the bricks were not wet.

The piers were built by a skilled bricklayer, and the mortars were mixed under his superintendence. The tests

were made with the Government testing-machine at the Arsenal.

Pier No. 1. (Bricks laid in common lime-mortar, two days old). This mortar was part of a lot prepared for use in the erection of a building then being built in Boston, and was such as is commonly used in building.

Size of pier, 8″ x 12″	Area, 96 sq. ins.
Length, 8 courses	$20\frac{3}{8}$ ins.
Weight	144 lbs.
Age	4 mo. 26 days.
Ultimate strength	150,000 lbs.
Time of test	45 min.

Under a load of 80,000 lbs. a longitudinal crack was opened in first and second courses; 90,000 lbs. extended the crack across four courses, also opening crack on the opposite side of the pier across seven courses. The pier sustained the maximum load five minutes, rapidly developing longitudinal cracks, and crushing some of the bricks.

Pier No. 2. (Brick laid in mortar composed of one part Portland cement and three parts lime-mortar).

Size, 8″ x 12″	Area, 96 sq. ins.
Length, 9 courses	$22\frac{1}{8}$ ins.
Weight	161 lbs.
Age	4 mos. 26 days.
Ultimate strength	290,000 lbs.
Time of test	55 min.

A load of 180,000 lbs. opened a longitudinal seam in the fourth course. Sustained the maximum load one minute. The pier failed by opening longitudinal seams, and did not break up when removed from the machine.

Pier No. 3. (Bricks laid in mortar composed of one part Newark and Rosendale cement, and three parts lime-mortar).

Size of pier, 8″ x 12″	Area, 96 sq. ins.
Length, 9 courses	$22\frac{1}{2}$ ins.
Weight	159 lbs.
Age	4 mos. 26 days.
Ultimate strength	245,000 lbs.
Time of test	20 min.

At 130,000 lbs. compression longitudinal seams appeared in the second and fourth courses. Rapid development of seams occurred under 220,000 lbs. The pier sustained the maximum load one minute, failing by splitting and crushing the bricks.

Pier No. 4. Brick laid in mortar composed of one part Orchard Roman cement and three parts lime-mortar.

Size of pier, 8″ x 12″	Area, 96 sq. ins.
Length, 9 courses	$22\frac{5}{8}$ ins.
Weight	158 lbs.
Age	4 mos. 26 days.
Ultimate strength	195,000 lbs.
Time of test	25 min.

At 100,000 lbs. pressure three bricks cracked, and at 150,000 lbs. pressure there were cracks in sight on each of the four faces. It sustained the maximum load one minute, and failed by cracking and crushing the bricks.

Pier No. 5. (Bricks laid in cement mixed in the proportion of one part Portland cement and two parts sand).

Size of pier, 8″ x 12″	Area, 96 sq. ins.
Length, 9 courses	23 ins.
Weight	166 lbs.
Age	4 mos. 26 days.
Ultimate strength	240,000 lbs.
Time of test	30 min.

At 125,000 lbs. pressure a crack appeared in the third course, and one in the fifth course. The pier failed by opening longitudinal seams. It did not break up when removed from the machine.

Pier No. 6. (Brick laid in cement composed of one part Newark and Rosendale cement, and two parts sand).

Size of pier, 8″ x 12″	Area, 96 sq. ins.
Length, 9 courses	23 1-16 ins.
Weight	167 lbs.
Age	4 mos. 26 days.
Ultimate strength	205,000 lbs.
Time of test	20 min.

At 68,000 lbs. pressure cracks were perceived in the third course from each end. Failed by opening longitudinal seams.

Pier No.. 7. (Bricks laid in cement composed of one part Orchard Roman cement and two parts sand).

Size of pier, 8" x 12"	Area, 96 sq. ins.
Length, 9 courses	23⅛ ins.
Weight	164 lbs.
Age	4 mos. 26 days.
Ultimate strength	185,000 lbs.
Time of test	20 min.

Commenced to crack when under 170,000 lbs. pressure. Failed by opening longitudinal seams and crushing the bricks. Pier did not break up when taken from the testing-machine.

Pier No. 8. (Four courses laid in Newark and Rosendale cement one part, and sand one part; remaining five courses laid in Portland cement one part to two parts of sand).

Size, 8" x 12"	Area, 96 sq. ins.
Length, 9 courses	23 1-16 ins.
Weight	167 lbs.
Age	4 mos. 26 days.
Ultimate strength	225,000 lbs.
Time of test	25 min.

Under 135,000 lbs. pressure the third course laid in Newark and Rosendale cement began to break off. When the pier failed the end laid in Newark and Rosendale cement was thoroughly cracked, while the opposite end (laid in Portland cement) had four longitudinal seams, one in each face. This shows that the mortar composed of one part Portland cement to two parts of sand is stronger than that of Newark and Rosendale cements mixed in the proportion of one part cement to one of sand.

The following table is arranged so as to show at a glance the strength of the piers laid with the different mortars, and to afford a ready means of comparison. It is interesting to compare the figures obtained from the tests, with those given in the hand-books. Mr. Trautwine, who is considered as gook authority as any one, says that ordinary brickwork cracks with 20 to 30 tons per square foot, which is equiva-

lent to 311 to 466 lbs. to the square inch. The *larger* number is *less than half* the pressure per square inch, which produced the first crack in the pier laid with lime-mortar.

8″ x 12″ PIER. Common bricks laid in—	Ultimate strength of pier.	Pressure per sq. in. under which pier commenced to crack.	Ultimate strength per sq. in.
	lbs.	lbs.	lbs.
Lime-mortar	150,000	833	1,562
Lime-mortar, 3 parts; Portland cement, 1 part	290,000	1,875	3,020
Lime-mortar, 3 parts; Newark and Rosendale cements, 1 part	245,000	1,354	2,552
Lime-mortar, 3 parts; Roman cement, 1 part	195,000	1,041	2,030
Portland cement, 1 part; sand, 2 parts	240,000	1,302	2,500
Newark and Rosendale cements, 1 part; sand, 2 parts	205,000	708	2,135
Roman cement, 1 part; sand, 2 parts	185,000	1,770	1,927

For first-rate brickwork in cement, Mr. Trautwine gives numbers which correspond to 770 to 1,088 lbs. to the square inch. These numbers are also very much less than those obtained from the tests of the piers laid in cement. The Portland cement used in building these piers was the kind known as Brooks, Shoobridge & Co.'s cement, and this with the other brands were furnished for the tests by Messrs. Waldo Bros., Boston, Mass.

After making the tests above described, a block of Selenitic concrete, consisting of two plates of Selenitic cement, 20″ x 12″, 1⅜″ thick, placed about 7 inches apart, and filled in with concrete, was tested under compression. The plates were dovetailed into the concrete. This block was exhibited at the recent fair of the Association.

Compression Area .... 180 sq. ins.
Weight .... 103 lbs.

Brass packing was used to secure an even bearing. The pressure was applied to the long sides of the block parallel to the faces. At 50,000 lbs. pressure, 277 lbs. to the square inch, one of the facings cracked. The block finally crushed under 120,000 lbs., 666 lbs. to the square inch, the facings being wedged off, and the central part crushed.

Miscellaneous Tables and Useful Memoranda.

THE WEIGHT OF A FOOT SUPERFICIAL OF WROUGHT AND CAST IRON, BRASS, COPPER AND LEAD.

Wrought-iron....	2.52	5.04	10.08	15.12	20.16	25.20	30.24	35.28	40.32
Cast-iron........	2.35	4.69	9.37	14.06	18.75	23.44	28.12	32.81	37.50
Brass	2.84	5.68	11.35	17.03	22.70	28.38	34.05	39.72	45.40
Copper..........	2.89	5.78	11.56	17.34	23.12	28.90	34.68	40.46	46.24
Lead, cast.......	3.70	7.39	14.78	22.17	29.56	36.95	44.34	51.73	59.12

EXAMPLE.—To find the weight of a bar of iron 4 feet long, 2 inches wide and ¾ inch thick, by the above table. 1 foot weighs 5.04 lbs., which if multiplied by 4 (the length) will give 20.16 lbs., the weight.

THE STRENGTH OF ROUND ROPES.

Hemp.		Iron Wire.		Steel Wire.	
Girth.	Bkg. Wt.	Girth.	Bkg. Wt.	Girth.	Bkg. Wt.
Ins.	Tons.	Ins.	Tons.	Ins.	Tons.
1	1-5	1	1½	1	2½
1½	½	1½	3	1¼	3
2	4-5	1¾	4	1⅜	4
2½	1¼	1⅞	5	1½	5¾
3	1 4-5	2	6	1¾	7½
3½	2½	2¼	7	1⅞	9
4	3¼	2½	9	2	10
4½	4	2¾	11	2¼	12½
5	5	3	14	2½	15½
6	7¼	3⅛	15	2¾	19
7	9¾	3½	19	3	22½
8	13	3¾	23	3½	31
9	16¼	4	25	4	40
10	20	4½	33	Factor for safety	
11	24	5	38	=1-6.	
12	29	6	55		

SAFE LOADS.

The greatest safe load per super foot in—

Granite piers	40 tons.
Cleveland sand stone	13 "
Brickwork in cement	3 "
Rubble masonry	2 "
Lime concrete foundation	$2\frac{1}{2}$ "

Allow for floors of—

Dwellings	$1\frac{1}{4}$ cwt. per ft. super.
Public buildings	$1\frac{1}{2}$ " "
Warehouses, etc.	$2\frac{1}{2}$ " "

WEIGHT WHICH FLOORS HAVE USUALLY TO SUSTAIN.

	Per ft. super.
Ordinary dwelling-house floors should be calculated to sustain, including the weight of the floor itself	$1\frac{1}{4}$ cwt.
Public buildings, lecture rooms, etc	$1\frac{1}{2}$ "
Warehouses, factories, etc.	$2\frac{1}{2}$ "

WEIGHT OF SHEET IRON.

Weight of square foot of Sheet Iron in pounds avoirdupois, the thickness being the number on the Wire Gauge.—No. 1 *is* 5-16 *of an inch; No.* 4, $\frac{1}{4}$; *No.* 11, $\frac{1}{8}$, *etc.*

No. on Wire Gauge.	Pounds Avoir.	No. on Wire Gauge.	Pounds Avoir.
1	12.5	12	4.62
2	12.	13	4.31
3	11.	14	4.
4	10.	15	3.95
5	9.	16	3.
6	8.	17	2.5
7	7.5	18	2.18
8	7.	19	1.93
9	6.	20	1.62
10	5.68	21	1.62
11	5.	22	1.37

WEIGHT OF CAST-IRON PLATES.

Weight of Cast-Iron Plate 12 *inches square.*

Thickness.	Weight.		Thickness.	Weight.	
Ins.	lbs.	oz.	Ins.	lbs.	oz.
$\frac{1}{8}$	4	$13\frac{3}{8}$	$\frac{5}{8}$	24	$2\frac{3}{4}$
$\frac{1}{4}$	9	$10\frac{5}{8}$	$\frac{3}{4}$	29	0
$\frac{3}{8}$	14	8	$\frac{7}{8}$	33	$13\frac{3}{8}$
$\frac{1}{2}$	19	$5\frac{3}{8}$	1	38	$10\frac{3}{4}$

WEIGHT OF BOILER IRON.

Weight of a square foot of Boiler Iron from ⅛ to 1 inch thick in pounds.

Thickness.	Weight.	Thickness.	Weight.
Ins.	Lbs.	Ins.	Lbs.
⅛	5.	⅝	25.
3-16	7.5	11-16	27.5
¼	10.	¾	30.
5-16	12.5	13-16	32.5
⅜	15.	⅞	35.
7-16	17.5	15-16	37.5
½	20.	1	40.
9-16	22.5		

WROUGHT IRON PIPES.

The weight of a lineal foot.

Bore.	Thickness of Metal in Parts of an Inch.							
	1-16	⅛	5-16	¼	5-16	⅜	7-16	½
Ins.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
¼	.20	.49	.87	1.32	1.86	2.48	3.18	3.96
⅜	.29	.66	1.16	1.65	2.27	2.97	3.76	4.62
½	.37	.82	1.36	1.98	2.68	3.47	4.34	5.29
⅝	.45	1.09	1.61	2.31	3.10	3.96	4.92	5.95
¾	.53	1.15	1.86	2.64	3.51	4.46	5.49	6.61
⅞	.62	1.32	2.10	2.97	3.92	4.96	6.07	7.27
1	.70	1.49	2.35	3.30	4.34	5.45	6.65	7.93
1¼	.86	1.81	2.85	3.99	5.16	6.44	7.81	9.25
1½	1.03	2.14	3.34	4.63	5.99	7.44	8.96	10.58
1¾	1.20	2.48	3.83	5.29	6.82	8.43	10.12	11.90
2	1.36	2.81	4.34	5.95	7.64	9.42	11.28	13.22
2¼	1.52	3.13	4.83	6.61	8.47	10.41	12.44	15.55
2½	1.69	3.47	5.33	7.27	9.30	11.40	13.59	15.87
2¾	1.86	3.80	5.82	7.93	10.12	12.40	14.75	17.19
3	2.02	4.13	6.32	8.60	10.95	13.39	15.91	18.52

ROUND AND FLAT IRON WIRE ROPES.

The weight of a fathom.

Round.				Flat.	
Circum.	Weight per fathom.	Circum.	Weight per fathom.	Size.	Weight per fathom.
Ins.	Lbs.	Ins.	Lbs.	Ins.	Lbs.
1	1	3¼	8½	1⅞ x ½	8
1½	1½	3⅜	9	2¼ x ½	11
1⅝	2	3½	10	2½ x ½	13
1¾	2½	3⅝	11	2¾ x ⅝	15
1⅞	3	3¾	12	3 x ⅝	16
2	3½	3⅞	13	3¼ x ⅝	18
2⅛	4	4	14	3½ x ⅝	20
2¼	4½	4¼	15	3¾ x	22
2⅜	5	4¾	16	4 x	25
2½	5½	4½	17½	4¼ x ¾	28
2⅝	6	4⅝	19	4½ x ¾	32
2¾	6½	4¾	20	4⅝ x ¾	34
2⅞	7	5	22	....	....
3	7½	5½	27	....	....
3⅛	8	6	32	....	....

COMPARATIVE WEIGHTS OF HEMP AND IRON AND STEEL WIRE ROPE.

Hemp.		Iron Wire.		Steel Wire.	
Circum.	Weight per fathom.	Circum.	Weight per fathom.	Circum.	Weight per fathom.
Ins.	Lbs.	Ins.	Lbs.	Ins.	Lbs.
2¾	2	1	1	....	....
3¾	3	1½	1½	1	1
4½	5	1¾	2½	1½	1½
5½	7	2	3½	1¾	2½
6	9	2¼	4½	2	3½
7	12	2½	5½	2¼	4½
8	16	3	7½	2½	5½
10	26	3½	10	2¾	6½
12	34	4	14	3½	10

CORRUGATED IRON ROOFING.

B. W. gauge.	Size of Sheets.	Weight per square.	No. of sup. ft. per ton.
	Ft. ins. ft. ins.	Cwts	
16	6 x 2 to 8 x 3	3⅓	800
18	6 x 2 " 8 x 3	2¼	1000
20	6 x 2 " 8 x 3	1¾	1250
22	6 x 2 " 7 x 2½	1½	1550
24	6 x 2 " 7 x 2½	1¼	1880
26	6 x 2 " 7 x 2½	1	2170

LEAD PIPE.

List of Calibre and Weight of Lead.

Calibre.	Weight per yard.	Average lengths.
	Lbs.	Yards.
⅜ inch light	2½	60
strong	3	50
½ inch extra light	2½ & 3½	60 & 48
light	4	40
medium	4½	36
strong	5 & 6	30 & 25
extra strong	7 & 8	22 & 20
⅝ inch extra light	4½	36
light	5	33
medium	6	28
strong	7	24
extra strong	8 & 9	21 & 18
¾ inch extra light	5	33
light	6	28
medium	7	24
strong	8	21
extra strong	9 & 10	18 & 16
1 inch extra light	5	33
light	6	28
medium	7	24
strong	8	21
extra strong	9 & 10	18 & 16
1¼ inch extra light	6	28
light	8	21
¼ inch medium	10	16
strong	12	14
extra strong	14	12
1½ inch extra light	10	17

LEAD PIPE (*Continued*).

Calibre.	Weight per yard.	Average lengths.	
	Lbs.	Yards.	
1½ inch light	11	15	
medium	12	1	
strong	14	20	
extra strong	16 & 18	17 & 16	In large coils.
1¾ inch light	14	20	
medium	16	17	
strong	18	15	
extra strong	20	14	
2 inch extra light	16	17	
light	18	15	
medium	20	14	Large coils.
strong	22	12	
extra strong	24	11	
2½ inch light	20	12 to 14 ft.	
medium	24	"	
strong	27	"	
extra strong	30 & 32	"	
3 inch light	27	"	
medium	30	"	
strong	34	"	

THE THICKNESS OF LEAD.

Weight in lbs., per ft. superficial.	Thickness in inches.	Weight in lbs., per ft. superficial.	Thickness in inches.
1	0.02	7	0.12
2	0.03	8	0.13
3	0.05	9	0.15
4	0.07	10	0.17
5	0.09	11	0.19
6	0.10	12	0.20

For roofs and gutters use 7 lbs. lead.

For ships and ridges use 6 lbs. lead.

For flushings use 5 lbs. lead.

Gutters should have a fall of at least 1 inch in 10 feet.

No sheet of lead should be laid in greater lengths than 10 or 12 feet without a drip to allow of expansion.

A pig of lead is about 3 feet long, and weighs from 1¼ to 1½ cwt.

Spanish pigs are about 1 cwt.

Joints to lead pipes require 1 lb. or solder for every inch diam.

SOLDERS.

For lead.—Tin, 1 part; lead, 2 parts.

For tin.—Pewter, 4 parts; tin, 1; bismuth, 1.

For pewter.—Bismuth, 2 parts; lead, 1 part; tin, 2.

For brass.—Brass, 2 parts; zinc, 1.

For gold.—Gold, 12 parts; silver, 2; copper, 4.

For silver.—Silver, 5 parts; brass, 6; zinc, 2.

Hard solder.—Copper, 2 parts; zinc, 1.

Soft solder.—Tin, 2 parts; lead, 1.

FLUXES FOR SOLDERING.

Tinned iron.—Resin or chloride of zinc.

Copper and brass.—Sal ammoniac or chloride of zinc.

Zinc.—Chloride of zinc.

Lead.—Resin.

THE WEIGHT A CAST-IRON COLUMN WILL SUSTAIN WITH SAFETY.

Length or Height in feet.	8	10	12	14	16	18	20	22	24
Diameter.	Weight in cwts.	Weight in cwts.	Weight in cwts.	Weight in cwts.	Weight in cwts.	Weight in cwts.	Weight in cwts.	Weight in cwts.	Weight in cwts.
2½ inches.	91	77	65	55	47	40	34	29	25
3 "	145	128	111	97	84	73	64	56	49
3½ "	214	191	172	156	135	119	106	94	83
4 "	288	266	242	220	198	178	160	144	130
4½ "	379	354	327	301	275	251	229	208	189
5 "	479	452	427	394	365	337	310	285	262
6 "	573	550	525	497	469	440	413	386	360
7 "	989	959	924	887	848	808	765	725	686
8 "	1289	1259	1224	1185	1142	1097	1052	1005	959
9 "	1672	1640	1603	1561	1515	1467	1416	1364	1311
10 "	2077	2045	2007	1964	1916	1865	1811	1755	1697
11 "	2520	2490	2450	2410	2358	2305	2248	2189	2127
12 "	3020	2970	2930	2900	2830	2780	2730	2670	2600

STRENGTH OF MATERIALS.

Resistance to Extension and Compression, in pounds per Square Inch Section of some materials.

Name of the Material.	Resistance to Extension.	Resistance to Compression.	Tensile Strength in Practice.	Comp. Strength in Practice.
White pine...	10,000	6,000	2,000	1,200
White oak....	15,000	7,500	3,000	1,500
Rock elm.....	16,000	8,011	3,200	1,602
Wrought iron.	60,000	50,000	12,000	10,000
Cast iron.....	20,000	100,000	4,000	20,000

In practice, from one-fifth to one-sixth of the strength is all that should be depended upon.

NAILS.

For 1000 shingles allow $3\frac{1}{2}$ to 5 lbs. 4d. nails; or 3 to $3\frac{1}{2}$ lbs. 3d. nails.

For 1000 laths, allow about 6 lbs. 3d. fine nails.

"	1000 feet clapboards,	about	18	lbs.	6d. box.
"	1000	" boarding boards,	20	"	8d. com.
"	1000	" "	25	"	10d. "
"	1000	" Top floors, sq. edge,	38	"	10d. floor.
"	1000	" " "	41	"	12d. "
"	1000	" " match'd blind nailed	35	"	10d. "
"	1000	" " " "	42	"	12d. "
"	10	" partition studs or studding,	1	"	10d. com.
"	1000	" furring, 1 x 3,	45	"	10d. "
"	1000	" furring, 1 x 2,	65	"	10d. "
"	1000	" pine finish, about	30	"	8d. finish

20d.	nails.	3 5/8	inches long,	36	nails to a	pound.
30d.	"	4	"	24	"	"
40d.	"	4 1/2	"	18	"	"
50d.	"	5 1/3	"	13	"	"
60d.	"	6	"	9	"	"
70d.	"	7	"	6	"	"

Nails made by different firms vary a little, but not enough to make any change in the foregoing table desirable.

TABLE OF FOREIGN WEIGHTS AND MEASURES.

Reduced to the Standard of the United States.

FRANCE.

Metre	3.28 feet.
Decimetre (1-10th metre)	3.94 inches.
Velt	2.00 galls.
Hectolitre	26.42 galls.
Decalitre	2.64 galls.
Litre	2.11 pints.
Kilolitre	35.32 feet.
Hectolitre	2.84 bush.
Decalitre	9.08 quarts.
Millier	2.205 lbs.
Quintal	220.54 lbs.
Kilogramme	2.21 lbs.

AMSTERDAM.

100 lbs. 1 centner	108.93 lbs.
Last of grain	85.25 bush.
Ahm of wine	41.00 galls.
Amsterdam foot	0.93 foot.
Antwerp foot	0.94 foot.
Rhineland foot	1.03 feet.
Amsterdam ell	2.26 feet.
Ell of the Hague	2.28 feet.
Ell of the Brabant	2.30 feet.

NETHERLANDS.

Ell	3.28 feet.
Mudde of Zak	2.84 bush.
Vat hectolitre	26.42 galls.
Kan litre	2.11 pints.
Pond kilogramme	2.21 lbs.

HAMBURG.

Last of grain	89.64 bush.
Ahm of wine	38.25 galls.
Hamburg foot	0.96 foot.
Ell	1.92 feet.

PRUSSIA.

100 lbs. of 2 Cologne marks each	103.11 lbs.
Quintal, 110 lbs	113.42 lbs.
Sheffel of grain	1.56 bush.
Eimar of wine	18.14 galls.
Ell of cloth	2.19 feet.
Foot	1.03 feet.

DENMARK.

100 lbs. 1 centner	110.28 lbs.
Barrel or toende of corn	3.95 bush.
Viertel of wine	2.04 galls.
Copenhagen or Rhineland foot	1.03 feet.

SWEDEN.

100 lbs. or 5 lispunds	73.76 lbs.
Kan of Corn	7.42 bush.
Last	75.00 bush.
Cann of wine	69.09 galls.
Ell of cloth	1.95 feet.

RUSSIA.

100 lbs. of 32 laths each	90.26 lbs.
Chertwert of grain	5.95 bush.
Vedro of wine	3.25 galls.
Petersburgh foot	1.18 feet.
Moscow foot	1.10 feet.
Pood	36.00 lbs.

SPAIN.

Quintal, or 4 arrobas	101.44 lbs.
Arroba	25.36 lbs.
Arroba of wine	4.43 galls.
Fanega of grain	1.60 bush.

PORTUGAL.

100 lbs	101.19 lbs.
22 lbs. (1 arroba)	22.26 lbs.
4 arrobas of 22 lbs. (1 quintal)	89.05 lbs.
Alquiere	4.75 bush.
Mojo of grain	23.03 bush.
Last of salt	70.00 bush.
Almude of wine	4.37 galls.

SICILY.

Cantar ogroso	192.50 lbs.
Cantaro sottile	175.00 lbs.
100 lbs	70.00 lbs.
Salma grossa of grain	9.77 bush.
Salma generale	7.85 bush.
Salma of wine	23.06 galls.

NAPLES.

Cantaro groso	196.50 lbs.
Cantaro picolo	106.00 lbs.
Carro of grain	52.24 bush.
Carro of wine	264.00 galls.

FOREIGN WEIGHTS AND MEASURES (*Continued*).

ROME.

Rubbio of grain... 8.36 bush.
Barih of wine..... 15.31 galls.

GENOA.

100 lbs. or peso groso.......... 76.87 lbs.
100 lbs. or peso sottile......... 69.89 lbs.
Mina of grain..... 3.43 bush.
Mezzarola of wine. 39.22 galls.

FLORENCE AND LEGHORN.

100 lbs. or 1 cantaro............ 74.86 lbs.
Moggio of grain... 16.59 bush.
Barile of wine..... 12.04 galls.

VENICE.

100 lbs. peso groso 105.18 lbs.
100 lbs. peso sottile............ 64.04 lbs.
Moggio of grain.. 9.08 bush.
Anifora of wine...137.00 galls.

TRIESTE.

100 lbs...........123.60 lbs.
Stajo of grain..... 2.34 bush.
Orna or eimer of wine............ 14.94 galls.
Ell for woolens... 2.22 feet.
Ell for silk....... 2.10 feet.

MALTA.

100 lbs. 1 cantar..174.50 lbs.
Salma of grain.... 8.22 bush.
Foot............. 0.85 foot.

SMYRNA.

100 lbs. (1 quintal).............129.48 lbs.
Oke .... 2.83 lbs.
Quillot of grain... 1.46 bush.
Quillot of wine... 13.50 galls.

CHINA.

Tail.............. 1.33 oz.
16 tails 1 catty.... 1.33 lbs.
100 catties 1 picul.133.25 lbs.

FORCE OF THE WIND.

Miles per Hour.	Feet per Minute.	Feet per Second.	Force in Pounds per Square Foot.	Description.
1	88	1.47	.005	Hardly perceptible.
2	176	2.93	.020	Just perceptible.
3	264	4.4	.044	
4	352	5.87	.079	Gentle breeze.
5	440	7.33	0.123	
10	880	14.67	0.492	Pleasant breeze.
15	1,320	22.	1.107	
20	1,760	29.3	1.970	Brisk gale.
25	2,200	26.6	3.067	
30	2,640	44.0	4.429	High wind.
35	3,080	51.3	6.027	
40	3,520	58.6	7.870	Very high wind.
45	3,960	66.0	9.900	
50	4,400	73.3	12.304	Storm.
60	5,280	88.0	17.733	Great storm.
70	6,160	102.7	24.153	
80	7,040	117.3	31.490	Hurricane.
100	8,800	146.6	49.200	

RELATIVE STRENGTH OF BODIES TO RESIST TORSION, LEAD BEING 1.

Tin	1.4	Swedish iron	9.5
Copper	4.3	English iron	10.1
Yellow brass	4.6	Blistered steel	16.6
Gun metal	5.0	Shear steel	17.0
Cast iron	9.0		

SURVEYOR'S LONG MEASURE FOR MEASURING DISTANCES, BOUNDARIES, AREAS, RAILWAYS, ETC.

7 92-100 inches	1 link.	4 rods	1 chain.
25 links	1 rod.	80 chains	1 mile.

EQUIVALENTS.

Mile.		Chains.		Rods.		Links.		Inches.
1	=	80	=	320	=	8,000	=	63,360
		1	=	4	=	100	=	792
						25	=	198
						1	=	7.92

Surveyor's long measure, scale of units, 7.92, 25, 4, 80.

TABLE OF MISCELLANEOUS LINEAR MEASURE.

3 inches	1 palm.	
4 inches	1 hand.	Used in measuring the height of horses at the shoulder.
9 inches	1 span.	
3 feet	1 pace or step.	
3.28 feet	1 metre.	
6 feet	1 fathom.	Used in measuring depths at sea.
880 fathoms	1 mile.	
3 geographical miles	1 league.	
60 " "	1 degree.	Of latitude.
69¼ statute "		Of longitude on the equator.

SURVEYOR'S SQUARE MEASURE, FOR MEASURING THE CONTENTS OF FARMS, FIELDS, ETC.

625 square links (*sq. l.*)	1 pole, *P.*
16 poles	1 square chain, *sq. ch.*
10 square chains	1 acre, *A.*
640 acres	1 square mile, *sq. mi.*
36 square miles (6 miles square)	1 township, *Tp.*

EQUIVALENTS.

Tp.		Sq. Mi.		A.		Sq. Ch.		P.		Sq. Links.
1	=	36	=	2304	=	230,400	=	3,686,400	=	2,304,000,000
		1	=	640	=	6,400	=	102,400	=	64,000,000
						10	=	160	=	10,000
						1	=	16	=	1,000
								1	=	625

Surveyor's square measure, scale of units, 625, 16, 10, 640, 36.

An ACRE is the unit of land measure, and is 10 square chains (10,000 links), or a piece of land 3 chains 16¼ links (or about 69½ yds.), on each of the four sides, or, if of a different shape, as much land as is embraced in that compass.

A ROOD is a quarter of an acre, or 40 perches, and contains 25,000 square links; if square, it should measure 1 chain and 58 links, or about 34¾ yds. on each side.

A PERCH (sometimes called a pole or rod) is the 160th of an acre, and contains 30¼ square yards, or 625 square links, and embraces 5½ yds., or 25 running links of the chain, on each of the four sides.

ARITHMETICAL SIGNS AND THEIR SIGNIFICATION.

$=$ Sign of Equality, and signifies as $4+12=16$.
$+$ " Addition, " as $8+8=16$ the sum.
$-$ " Subtraction " as $12-4=8$ the remainder.
$\times$ " Multiplication " as $12\times3=36$ the product.
$\div$ " Division " as $24\div3=8$ or $24\text{-}3=8$.
$\surd$ " Square root " Evolution or Extraction of Square Root.
6^2 Sign of to be Squared " thus $8^2=64$ Involution, or
7^3 " to be cubed " thus $3^3=27$ the Raising of Powers.

EFFECTS OF HEAT ON VARIOUS BODIES.

Fine gold melts	2590°	Heat, cherrry red	1500°
" silver "	1250	" bright "	1860
Copper melts	2548	" red visible by day	1077
Wrought-iron melts	3980	" white	2900
Cast " "	3479	Mercury boils	662
Bright red " in the dark	752	" volatilizes	680
Red hot " in twilight	884	Platinum melts	3080
Glass melts	2377	Zinc melts	740
Common fire	790	Highest natural temperature (Egypt)	117
Brass melts	1900		
Air furnace	3300	Greatest natural cold (below zero)	56
Antimony melts	951		
Bismuth "	476	" artificial " "	106
Cadmium	600	Heat of human blood	98
Steel	2500	Snow and salt, equal parts	0
Lead	504	Ice melts	32
Tin	421	Water in *vacuo* boils	98
		Furnace under steam boiler	1100

WEIGHT OF CAST-IRON PIPES OF DIFFERENT THICKNESSES, FROM 1 INCH TO 22 INCHES IN DIAMETER. 1 FOOT IN LENGTH.

Diam.	Thickness.	Weight.	Diam.	Thickness.	Weight.	Diam.	Thickness.	Weight.
Ins.	Ins.	Lbs.	Ins.	Ins.	Lbs.	Ins.	Ins.	Lbs.
1.	.¼	3.06	5.	.½	26.94		1.	102.9
	.⅜	5.05		.⅝	34.34	10.	.½	51.46
1.¼	.¼	3.67		.¾	42.28		.⅝	65.08
	.⅜	6.	5.½	.½	29.4		.¾	78.99
1.½	.⅜	6.89		.⅝	37.44		.⅞	93.24
	.½	9.8		.¾	45.94		1.	108.84
1.¾	.⅜	7.8	6.	.½	31.82	10.½	.½	53.88
	.½	11.04		.⅝	40.56		.⅝	68.14
2.	.⅜	8.74		.¾	49.6		.¾	82.68
	.½	12.23		.⅞	58.96		.⅞	97.44
2.¼	.⅜	9.65	6.½	.½	34.32		1.	112.68
	.½	13.48		.⅝	43.68	11.	.½	56.34
2.½	.⅜	10.57		.¾	53.3		.⅝	71.19
	.½	14.66		.⅞	63.18		.¾	86.4
	.⅝	19.05	7.	.½	36.66		.⅞	101.83
2.¾	.⅜	11.54		.⅝	46.8		1.	117.6
	.½	15.91		.¾	56.96	11.½	.½	58.82
	.⅝	20.59		.⅞	67.6		.⅝	74.28
3.	.⅜	12.28		1.	78.39		.¾	90.06
	.½	17.15	7.½	.½	39.22		.⅞	106.14
	.⅝	22.15		.⅝	49.92		1.	122.62
	.¾	27.56		.¾	60.48	12.	.½	61.26
3.¼	.½	18.4		.⅞	71.76		.⅝	77.36
	.⅝	23.72		1.	83.28		.¾	93.7
	.¾	29.64	8.	.½	41.64		.⅞	110.48
3.½	.½	19.66		.⅝	52.68		1.	127.42
	.⅝	25.27		.¾	64.27	12.½	.½	63.7
	.¾	31.2		.⅞	76.12		.⅝	80.4
3.¾	.½	20.9		1.	88.2		.¾	97.4
	.⅝	26.83	8.½	.½	44.11		.⅞	114.72
	.¾	33.07		.⅝	56.16		1.	132.35
4.	.½	22.05		.¾	68.	13.	.½	66.14
	.⅝	28.28		.⅞	80.5		.⅝	83.46
	.¾	34.94		1.	93.28		.¾	101.08
4.¼	.½	23.35	9.	.½	46.5		.⅞	118.97
	.⅝	29.85		.⅝	59.92		1.	137.28
	.¾	36.73		.¾	71.7	13.½	.½	68.64
4.½	.½	24.49		.⅞	84.7		.⅝	86.55
	.⅝	31.4		1.	97.98		.¾	104.76
	.¾	38.58	9.½	.½	48.98		.⅞	123.3
4.¾	.½	25.7		.⅝	62.02		1.	142.16
	.⅝	32.91		.¾	75.32	14.	.½	71.07
	.¾	40.43		.⅞	88.98		.⅝	89.61

WEIGHT OF CAST-IRON PIPES (*Continued*,

Diam	Thickness.	Weight.	Diam.	Thickness.	Weight.	Diam.	Thickness.	Weight.
Ins.	ins.	Lbs.	Ins.	Ins.	Lbs.	Ins.	Ins.	Lbs.
	$.\frac{3}{4}$	108.46		$.\frac{5}{8}$	101.82	18.	$.\frac{5}{8}$	114.1
	$.\frac{7}{8}$	127.6		$.\frac{3}{4}$	123.14		$.\frac{3}{4}$	137.84
	1.	147.03		$.\frac{7}{8}$	144.76		$.\frac{7}{8}$	161.9
14.$\frac{1}{2}$	$.\frac{1}{2}$	73.72		1.	166.6		1.	186.24
	$.\frac{5}{8}$	92.66	16.$\frac{1}{2}$	$.\frac{1}{2}$	83.3	19.	$.\frac{5}{8}$	120.24
	$.\frac{3}{4}$	112.1		$.\frac{5}{8}$	104.82		$.\frac{3}{4}$	145.2
	$.\frac{7}{8}$	131.86		$.\frac{3}{4}$	126.79		$.\frac{7}{8}$	170.47
	1.	151.92		$.\frac{7}{8}$	149.02		1.	195.92
15.	$.\frac{1}{2}$	75.96		1.	171.6	20.	$.\frac{5}{8}$	126.33
	$.\frac{5}{8}$	95.72	17.	$.\frac{1}{2}$	85.73		$.\frac{3}{4}$	152.53
	$.\frac{3}{4}$	115.78		$.\frac{5}{8}$	107.96		$.\frac{7}{8}$	179.02
	$.\frac{7}{8}$	136.15		$.\frac{3}{4}$	130.48		1.	205.8
	1.	156.82		$.\frac{7}{8}$	153.3	21.	$.\frac{5}{8}$	132.5
15.$\frac{1}{2}$	$.\frac{1}{2}$	78.4		1.	176.58		$.\frac{3}{4}$	159.84
	$.\frac{5}{8}$	98.78	17.$\frac{1}{2}$	$.\frac{1}{2}$	88.23		$.\frac{7}{8}$	187.6
	$.\frac{3}{4}$	119.49		$.\frac{5}{8}$	111.06		1.	215.52
	$.\frac{7}{8}$	140.4		$.\frac{3}{4}$	134.16	22.	$.\frac{5}{8}$	138.6
	1.	161.82		$.\frac{7}{8}$	157.59		$.\frac{3}{4}$	167.24
16.	$.\frac{1}{2}$	80.87		1.	181.33		$.\frac{7}{8}$	196.46

TIME IN WHICH A SUM WILL DOUBLE.

Rate per cent.	Simple Interest.	Compound Interest.
2	50 years.	35 years 1 day.
2$\frac{1}{2}$	40 years.	28 years 26 days.
3	33 years 4 months.	23 years 164 days.
3$\frac{1}{2}$	28 years 208 days.	20 years 54 days.
4	25 years.	17 years 246 days.
4$\frac{1}{2}$	22 years 81 days.	15 years 273 days.
5	20 years.	15 years 75 days.
6	16 years 8 months.	14 years 327 days.
7	14 years 104 days.	10 years 89 days.
8	12$\frac{1}{2}$ years.	9 years 2 days.
9	11 years 40 days.	8 years 16 days.
10	10 years.	7 years 100 days.

NAMES AND DIMENSIONS OF VARIOUS SIZES OF PAPER.

PRINT.	
Medium	19 x 24
Royal (20 x 24)	20 x 25
Super Royal	22 x 28
Imperial	22 x 32
Medium and a half	24 x 30
Small Double Medium	24 x 36
Double Medium	24 x 38
Double Royal	26 x 40
Double Super Royal	28 x 42
Double Super Royal	29 x 43
Broad Twelves	23 x 41
Double imperial	32 x 46
FOLDED.	
Billet Note	6 x 8
Octavo Note	7 x 9
Commercial Note	8 x 10
Packet Note	9 x 11
Bath Note	8½ x 14
Letter	10 x 16
Commercial Letter	11 x 17
Packet Post	11½ x 18
Foolscap	12½ x 16
FLAT.	
Legal Cap	13 x 16
Flat Cap	14 x 17
Crown	15 x 19
Double Flat Letter	16 x 20
Demy	16 x 21
Folio Post	17 x 22
Check Folio	17 x 24
Double Cap	17 x 28
Extra Size Folio	19 x 23
Medium	18 x 23
Royal	19 x 24
Super Royal	20 x 28
Imperial	22 x 30
Double Demy	21 x 31
Elephant	22¼ x 27¾
Columbier	23 x 31¼
Atlas	26 x 33
Double Elephant	26 x 40

EXPLOSIVE FORCE OF VARIOUS SUBSTANCES USED FOR BLASTING, ETC.

	Heat.	Volume of Gas.	Estimated Explosive Force.
Blasting powder	509	0.173 litre.	88
Artillery "	608	0.225 "	137
Sporting "	641	0.216 "	139
Powder, nitrate of soda for its base.	764	0.248 "	190
Powder, chlorate of pot. for its base	972	0.318 "	309
Gun cotton	590	0.801 "	472
Picric acid	687	0.780 "	536
Picrate potash	578	0.585 "	680
Gun cotton mixed with chl. potash.	1420	0.484 "	680
Picric acid " " " "	1424	0.408 "	582
Picrate " " " "	1422	0.337 "	478
Nitro-glycerin	1320	0.710 "	939

The above instructive table is by the celebrated M. Berthelot, who further describes nitro-glycerin "as really the ideal of portable force. It burns completely without residue; in fact, gives an excess of oxygen; it develops twice as much heat as powder, three and a half times more gas, and has

seven times the explosive force, weight for weight, and, taken volume for volume, it possesses twelve times more energy." From the extreme danger of the work, none but a competent chemist should attempt to manufacture it.

A TABLE OF DAILY SAVINGS AT COMPOUND INTEREST.

Cents per Day.	Per Year.	In Ten Years.	Fifty Years.
$2\frac{3}{4}$	$10	$130	$2,900
$5\frac{1}{4}$	20	260	5,800
11	40	520	11,600
$27\frac{1}{2}$	100	1,300	29,000
55	200	2,600	58,000
1.10	400	5,200	116,000
1.37	500	6,500	145,000

TABLE TO FIND THE NUMBER OF BRICK REQUIRED TO CONSTRUCT ANY BUILDING, EMBRACING WALLS, FROM 4 INCHES TO 20 INCHES THICK, RECKONING 7 BRICKS TO EACH SUPERFICIAL FOOT.

Example.—Required the number of bricks in 100 superficial feet of wall 12 inches thick. Under 12 inch, and opposite 100, you will find the answer, 2250, the number of bricks required.

Super-ficial feet of Wall.	Number of Bricks to Thickness of.					
	4-inch.	8-inch.	12-inch.	16-inch.	20-inch.	24-inch.
1	7	15	23	30	38	45
2	15	30	45	60	75	90
3	23	45	68	90	113	135
4	30	60	90	120	150	180
5	38	75	113	150	188	225
6	45	90	135	180	225	270
7	53	105	158	210	263	315
8	60	120	180	240	300	360
9	68	135	203	270	338	405
10	75	150	225	300	375	450
20	150	300	450	600	750	900
30	225	450	675	900	1125	1350
40	300	600	900	1200	1500	1800
50	375	750	1125	1500	1875	2250
60	450	900	1350	1800	2250	2700
70	525	1050	1575	2100	2625	3150
80	600	1200	1800	2400	3000	3600
90	675	1350	2025	2700	3375	4050
100	750	1500	2250	3000	3750	4500

TABLE TO FIND THE NUMBER OF BRICK, ETC. (*Continued*).

Superficial feet of Wall	Number of Bricks to Thickness of.					
	4-inch.	8-inch.	12-inch.	16-inch.	20-inch.	24-inch.
200	1500	3000	4500	6000	7500	9000
300	2250	4500	6750	9000	11250	13500
400	3000	6000	9000	12000	15000	18000
500	3750	7500	11250	15000	18750	22500
600	4500	9000	13500	18000	22500	27000
700	5250	10500	15750	21000	26250	31500
800	6000	12000	18000	24000	30000	36000
900	6750	13500	20250	27000	33750	45000
1000	7500	15000	22500	30000	37500	45000

1000 Shingles, laid 4 inches to the weather, will cover 100 sq. ft. of surface, and 5 lbs. of shingle nails will fasten them on.

One-fifth more siding and flooring is needed than the number of sq. feet. of surface to be covered, because of the lap in the siding and matching.

1000 Laths will cover 70 yards of surface, and 11 lbs. of lath nails will nail them on. 8 bushels of good lime, 16 bushels of sand, and 1 bushel of hair, will make enough good mortar to plaster 100 sq. yds.

A cord of stone, 3 bushels of lime, and a cubic yard of sand, will lay 100 cubic ft. of wall.

5 courses of brick will lay 1 ft. in height on a chimney, 16 bricks in a course will make a flue 4 ins. wide and 12 ins. long, and 24 bricks in a course will make a flue 8 ins. wide and 16 ins. long.

Cement, 1 bush., and sand, 2 bush., will cover 3½ sq. yds. 1 in. thick, 4½ sq. yds. ¾ inch thick, and 6¾ sq. yds. ½ inch thick. 1 bush. cement and 1 of sand will cover 2¼ sq. yds. 1 in thick, 3 sq. yds. ¾ inch thick, and 4½ sq. yds. ½ inch thick.

8 lbs. of *Asphalte Flooring* composition will cover 1 superficial ft. 3/4 inch thick. 308 pounds of finely-ground cement will make from 3.7 to 3.8 cubic feet of stiff paste. 1 cwt. of mastic and 1 gal. of oil will cover 1½ yds. at 3/4, or 2½ at ½ inch in thickness. *Pointing Mortar* consists, by weight, of finely-ground cement, 1 part to from 3 to 3⅓ parts of fine silicious sand, mix under cover, in small quantities at a time.

1 bundle of 16-inch shingles will cover 30 square ft.; 1 bundle of 18-inch shingles will lay 33 square ft., when laid 5½ ins. to the weather; 6 lbs. 4d. nails will lay 1000 split pine shingles.

130 yards of lath, lay and set, require 1 load of laths, 10,000 nails, 2½ cwt. of lime, 1½ double load of sand, and 7 bushels of hair; plasterer, laborer and boy, 6 days each.

Render and Set. 100 yards require 1½ cwt. of lime, 1 double load of sand, and 4 bushels of hair; plasterer, laborer and boy, 3 days each.

Setting. 375 yards require 1½ cwt. of lime and 5 bushels of hair.

In lathing, 1 bundle of laths and 384 nails will cover 5 yards. In *rendering*, 187½ yards require 1½ cwt. of lime, 2 double loads of sand, and 5 bushels of hair. *Floating* requires more labor, but only half as much material as rendering.

1000 bricks, closely stacked, occupy 56 cubic feet; 1000 old bricks, cleaned and loosely stacked, occupy 72 cubic ft.

1 rod of brickwork requires 126 gals. water to slack the lime and mix the mortar. Bricks absorb 1-15 of their weight in water. No. of bricks in cubic yard, 384. A bricklayer's hod will hold 20 bricks, or ⅔ cubic ft. of mortar, or ½ bushel, nearly.

TABLE SHOWING DIAMETER AND HEIGHT OF CHIMNEY FOR ANY BOILER.

H. P. of Boiler	Alt. of Chimney in Feet.	Interior Diameter at Top	H. P. of Boiler.	Alt of Chimney in Feet.	Interior Diameter at Top.
10	60	14 inches.	70	120	30 inches.
12	75	14 "	90	120	34 "
16	90	16 "	120	135	38 "
20	99	17 "	160	150	43 "
30	105	21 "	200	165	47 "
50	120	26 "	250	180	52 "
60	120	27 "	380	195	57 "

SLATING. The pitch of a slated roof should be about 1 in height to 4 in length; the usual lap is about 3 ins., but it is sometimes 4. Each slate should be fastened by 2 nails, either of copper or zinc. A square of slate is 100 superficial feet, allowances being made for the trouble of cutting the slates at the hips, eaves, round chimneys, etc. The sides and bottom edges of the slates should be trimmed, and the nail holes punched as near the head as possible; they should be sorted in sizes, when they are not all of one size, and the smallest size placed near the ridge. The thickness of slates varies from 3-16 to 5-16 of an inch, and their weight from 2.6 to 4.53 lbs. per square foot. The following table of sizes, etc., of roofing slates, is very useful:

Description.	Size. Length. ft.	Size. Length. in.	Size. Bre'th. ft.	Size. Bre'th. in.	Average gauge in inches.	No. of squares 1200 will cover.	Weight per 1200 in tons.	No. required to cover one square.	No. of nails required to one square.
Doubles . .	1	1	0	6	5½	2	¾	480	480
Ladies	1	4	0	8	7	4½	1¼	280	280
Count'sses	1	8	0	10	9	7	2	176	352
Duchesses	2	0	1	0	10½	10	3	127	254
Imperials.	2	6	2	0	a ton will cover 2¼ to 2½ squares.				
Rags and Queens	3	0	2	0					
Westmorel'ds of various sizes									

The next table exhibits the comparative weight of various roof coverings.

	Weight.	Least Slope.
Plain tiles, per square of 100 sup'l feet.	8 to 18 cwt.	$26\frac{1}{2}$ to 30°
Pantiles	$9\frac{1}{4}$ cwt.	....
Slating, an average....................	7 to 9 cwt.	$25\frac{1}{2}$ to 30°
Lead, 7 lbs. per sup'l feet.............	$6\frac{1}{2}$ cwt.	4°
Corrugated iron........................	3 cwt.	4°
Copper, or zinc, 16 ozs. per sup'l feet...	1 cwt.	4°
Timber framing for slated or tiled roofs..	560 to 672 lbs.	....
Boarding, $\frac{3}{4}$ in. thick..................	$2\frac{1}{2}$ cwt.	25°
Boarding, $1\frac{1}{2}$ in. thick..................	5 cwt.	25°
Additional load for pressure of wind...	35 cwt.	....
Gothic roofs, steepest angle............	....	60°

STAIR-CASES.

Width of Tread.	Height of Riser.	Width of Tread.	Height of Riser.
6 inches	$8\frac{1}{2}$ inches.	10 inches	$6\frac{1}{2}$ inches.
7 "	8 "	11 "	6 "
8 "	$7\frac{1}{2}$ "	12 "	$5\frac{1}{2}$ "
9 "	7 "	13 "	5 "

PAINTING.

1 gal.	priming color	will cover	50	superficial	yards.
1 "	white zinc	"	50	"	"
1 "	white paint	"	44	"	"
1 "	lead color	"	50	"	"
1 "	black paint	"	50	"	"
1 "	stone color	"	44	"	"
1 "	yellow paint	"	44	"	"
1 "	blue color	"	45	"	"
1 "	green paint	"	45	"	"
1 "	bright emer. green	"	25	"	"
1 "	bronze green	"	45	"	"

One pound of paint will cover about 4 superficial yards the first coat, and about 6 yards each additional coat. One pound of putty for stopping every 20 yards. One gallon of

tar, and 1 lb. pitch, will cover 12 yds. superficial the first coat, and 17 yds. each additional coat.

MEASUREMENT OF STONE OR BRICK WORK.

1. *Perch, Masons' or Quarrymen's Measure,*

16½ feet long, 16 inches wide, 12 " high	=	22 cubic feet. To be measured in wall.
16½ feet long, 18 inches wide, 12 " high	=	24.75 cubic feet. To be measured in pile.

1 cubic yard = 3 feet × 3 feet × 3 feet = 27 cubic feet. The cubic yard has become the standard for all contract work of late years. Stone walls less than 16 inches thick count as if 16 inches thick to masons; over 16 inches thick, each additional inch is counted.

NUMBER OF BRICK REQUIRED IN WALL PER SQUARE FOOT FACE OF WALL.

Thickness of wall.		Thickness of wall.	
4 inches	7½	24 inches	46
8 "	15	28 "	52½
12 "	22½	32 "	60
16 "	30	36 "	67½
20 "	37½	42 "	75

Cubic yard = 600 bricks in wall.

Perch (22 cubic feet) = 500 bricks in wall.

To pave 1 sq. yard on flat requires 48 bricks.

" 1 " edge " 68 "

STRENGTH OF WOODS.

The following tabulated form shows the results of Mr. Hodgkinson's experiments on the crushing strengths of different woods per square inch of section. The samples crushed were short cylinders 1 inch diameter, and 2 inches long, flat at the ends. The results given in the first column are those obtained when the wood was moderately dry. The samples noted in the second column were kept seasoning 2

months longer than the first. The third column is appended by the author, to illustrate the resilience or toughness of certain woods.

Kind of Wood.	Crushing Strength per Square Inch of Section.	Length in Feet of a Rod 1 Inch Square that would Break by its own Weight.
Alder	6831 to 6960	
Ash	8683 to 9363	42,080
Bay	7518 to 7518	
Box	10300	
Beech	7733 to 7363	38,940
Birch	10300	
English Birch	3297 to 6402	
Cedar	5674 to 5863	
Deal, Christiana	....	55,500
Red Deal	5748 to 6586	
White Deal	6781 to 7299	
Hornbeam	7300	
Elder	7451 to 9973	
Elm	7451 to 10331	39,050
Fir (Memel)	....	40,500
Fir (Spruce)	6499 to 6819	
Larch	....	42,160
Mahogany	8198 to 8198	
Lignum Vitæ	9900	
Oak (Quebec)	4231 to 5982	
Oak (English)	6484 to 10058	32,900
Pine (Pitch)	6790 to 6790	
Pine (Red)	5395 to 7518	
Poplar	3107 to 5142	
Plum (Dry)	8241 to 10493	
Sycamore	....	35,800
Teak	8241 to 12101	36,049
Walnut	6063 to 7227	
Willow	2898 to 6128	

PERMANENT LOADS ON BRIDGES, ETC.

For rough calculations the weight of the bridge itself may be assumed to be (in wrought-iron bridges):

For 30 feet spans, single line	....	560 lbs. per foot run.
" 60 " "	....	672 " "
" 100 " "	....	1,008 " "
" 150 " "	....	1,344 " "
" 200 " "	....	1,680 " "

Dense crowds average 120 lbs. per square foot.

For flooring, 168 to 224 lbs. per square foot, exclusive of the weight of the flooring, is generally allowed.

In storehouses, from 224 to 450 lbs. per square foot.

Beams of timber, when laid with their concentric layers vertical, are stronger than when laid horizontal, in the proportion of 8 to 7.

Mercury freezes at 40° below zero, and melts at 39°. Ether freezes at 47° below zero; wine freezes at 20°; sea water freezes at 28°3. Alcohol has been exposed to 110° and 120° below zero without freezing. Granite decomposes at a red heat. The second's pendulum, of 39.139 ins., is lengthened by 30° of temperature 128th of an inch, or 8 vibrations in 24 hours.

SAFE LOAD IN STRUCTURES, INCLUDING WEIGHT OF STRUCTURE.

In cast-iron columns	$\frac{1}{4}$ breaking weight.
Wrought-iron structures	$\frac{1}{4}$ " "
In cast-iron girders for tanks	$\frac{1}{4}$ " "
In cast-iron for bridges and tanks	1-6 " "
In timber	1-10 " "
Stone and bricks	$\frac{1}{8}$ " "

WEIGHT OF LUMBER PER THOUSAND (M.) FEET BOARD MEASURE.

	Dry.	Partly Seasoned.	Green.
Pine and hemlock	2,500 lbs.	2,700 lbs.	3,000 lbs.
Norway and yellow pine	3,000 "	4,000 "	5,000 "
Oak and walnut	4,000 "	5,000 "	
Ash and maple	3,500 "	4,000 "	

WEIGHTS OF CORDWOOD.

	lbs.	Carbon.		lbs.	Carbon.
1 cord of hickory	4468	100	1 cord of Canada pine	1870	42
" hard maple	2864	58	" yellow oak	2920	61
" beech	3234	64	" white oak	1870	81
" ash	3449	79	" Lombardy poplar	1775	41
" birch	2368	49	" red oak	3255	70
" pitch pine	1903	43			

TENSILE STRENGTH OF DIFFERENT KINDS OF WOOD, SHOWING THE WEIGHT OR POWER REQUIRED TO TEAR ASUNDER 1 SQUARE INCH.

	Lbs.		Lbs.
Lance	23,000	Pitch Pine	12,000
Locust	25,000	White Pine (American)	11,800
Mahogany	21,000	White Oak "	11,500
Box	20,000	Lignum vitæ	11,800
African Oak	14,500	Beech	11,500
Bay	14,500	Chestnut, sweet	10,500
Teak	14,000	Maple	10,500
Cedar	14,000	White Spruce	10,290
Ash	14,000	English Oak	10,000
Oak, seasoned	13,600	Pear	9,800
Elm	13,400	Larch	9,500
Sycamore	13,000	Mahogany, Spanish	8,000
Willow	13,000	Walnut	7,800
Christiana Deal	12,400	Poplar	7,000
Spanish Mahogany	12,000	Cypress	6,000

SPECIFIC GRAVITIES AND WEIGHTS OF METALS, WOODS, LIQUIDS, ETC.

Engineers' and Contractors' Pocket Book.

METALS.				STONES, EARTHS, ETC.			
Names.	Weight, water being 1000.	Number of cub. ins. in a lb.	Weight of a cub. in. in lbs.	Names.	Weight, water being 1000.	Weight of a cub. foot in lbs.	Number of cub. feet in a ton.
Platina	19500	1.417	.7053	Marble, aver'ge	2720	170.00	13
Pure gold	19258	1.435	.6965	Granite "	2651	165.68	13½
Mercury	13560	2.038	.4904	Purbeck stone	2601	162.56	13¾
Lead	11352	2.435	.4105	Portland "	2570	160.62	14
Pure silver	10474	2.638	.3788	Bristol "	2554	159.62	14
Bismuth	9823	2.814	.3552	Millstone "	2484	155.25	14½
Copper, cast	8788	3.146	.3178	Paving "	2415	150.93	14¾
" sheet	8910	3.103	.3225	Craigleith "	2362	147.62	15
Brass, cast	7824	3.533	.3036	Grindstone	2143	133.93	16¾
" sheet	8396	3.293	.3037	Chalk, British	2781	173.81	12¾
Iron, cast	7264	3.806	.263	Brick	2000	125.00	17
" bar	7700	3.592	.279	Coal, Scotch	1300	81.15	27½
Steel, soft	7833	3.530	.2833	" Newc'stle	1270	79.37	28¼
" hard	7816	3.537	.2827	" Staffords'e	1240	77.50	29
Tin cast	7291	3.790	.2636	" Cannel	1238	77.37	29
Zinc, cast	7190	3.845	.26				

SPECIFIC GRAVITIES, ETC., (*Continued*).

WOODS.

Names.	Weight, water being 1000.	Number of cub. ins. in a lb.	Weight of a cub. in. in lbs.
Lignum vitæ...	1331	83.31	26¾
Box, French...	1328	83.00	27
" Dutch...	912	58.00	38½
Ebony, Indian.	1209	75.56	29½
" Americ'n	1331	83.18	27
Oak, just felled	1113	69.56	32¼
" seasoned..	743	46.43	48¼
Bog oak of Irel'd	1046	65.37	34¼
Mahog'ny Sp'sh	1063	66.43	33¾
" bay wood	637	39.81	56¼
Medlar tree....	944	59.00	38
Logwood......	913	57.06	39¼
Olive tree.....	927	57.93	38½
Beech.........	852	53.25	42
Ash..........	845	52.81	42½
Alder.........	800	50.00	44¾
Apple-tree.....	793	49.56	45¼
Plum-tree.....	755	47.18	47¼
Maple.........	752	47.00	47½
Teak..........	750	46.87	48
Cherry-tree....	715	44.68	50
Elm..........	673	42.06	53¼
Walnut........	671	41.93	53½
Red pine......	657	47.06	54½
Yellow "......	652	40.76	55
Pear-tree......	650	40.62	55
Syc'm're, chestnut, and lime-tree, each....	604	37.75	59¼
Willow........	585	36.50	61¼
Popl'r, white Sp	529	33.06	67¾
" common	383	23.93	93
Cedar..........	561	35.06	64
White pine....	551	34.43	65
Larch..........	530	33.02	68
Cork..........	240	15.00	149

LIQUIDS.

Names.	Weight, water being 1000.	Number of cub-feet in a ton.
Acid, sulphuric	1850	18.5
" nitric....	1271	12.7
" muriatic.	1200	12.0
" fluoric ..	1060	10.6
" citric....	1034	10.3
" acetic....	1062	10.6
Water from Baltic.......	1015	10.2
" from the Dead Sea	1240	12.4
" from the Mediter'n	1029	10.3
" from the Irish Ch'l	1028	10.2
" ice.... .	1001	10.1
" distilled.	1000	10.0
Oils, expresed.		
linseed...	940	9.4
sw't alm'd	932	9.3
whale ...	923	9.2
hempseed	926	9.3
olive	915	9.2
Oils, essential .		
cinnamon	1043	10.4
lavender .	894	8.9
turp'ntine	870	8.7
amber....	868	8.7
Alcohol of commerce, at 60° Fahrenheit ..	825	8.2
Alcohol, absolute	797	7.9
Ether, nitric...	908	9.1
" muriatic	729	7.3
Proof spirit....	922	9.2
Tar	1015	10.1
Vinegar, dist'ld	1009	10.1

NUMBER OF FEET IN LENGTH OF THE FOLLOWING DIMENSIONS OF TIMBER REQUIRED TO MAKE 1000 FEET OF BOARD AND CUBIC MEASURE RESPECTIVELY.

Size.	No. of feet in length to make 1000 ft. cubic m.	Size.	No. of feet in length to make 1000 ft. board m.	Size.	No. of feet in length to make 1000 ft. board m.
5 x 5	5,760	2 x 6	1,000	6 x 10	200
5 x 6	4,800	2 x 7	857.2	6 x 11	181.10
5 x 7	4,114.3	2 x 8	750	6 x 12	166.8
5 x 8	3,600	2 x 9	666.8	7 x 7	244.11
5 x 9	3,200	2 x 10	600	7 x 8	214.3
5 x 10	2,880	2 x 11	545.6	7 x 9	190.6
5 x 11	2,618.2	2 x 12	500	7 x 10	171.5
5 x 12	2,400	2½ x 5	960	7 x 11	155.10
6 x 6	4,000	2½ x 6	800	7 x 12	142.10
6 x 7	3,428.7	2½ x 7	685.9	8 x 8	187.6
6 x 8	3,000	2½ x 8	600	8 x 9	166.8
6 x 9	2,666.8	2½ x 9	533.4	8 x 10	150
6 x 10	2,400	2½ x 10	480	8 x 11	136.4
6 x 11	2,181.8	3 x 5	800	8 x 12	125
6 x 12	2,000	3 x 6	666.8	9 x 9	148.2
7 x 7	2,938.9	3 x 7	571.5	9 x 10	133.4
7 x 8	2,571.4	3 x 8	500	9 x 11	121.3
7 x 9	2,285.8	3 x 9	444.4	9 x 12	111.2
7 x 10	2,057.3	3 x 10	400	10 x 10	120
7 x 11	1,870.1	3 x 11	363.7	10 x 11	109.1
7 x 12	1,714.3	3 x 12	333.4	10 x 12	100
8 x 8	2,550	4 x 5	600	11 x 11	99.2
8 x 9	2,000	4 x 6	500	11 x 12	90.9
8 x 10	1,800	4 x 7	428.7	12 x 12	83.4
8 x 11	1,636.4	4 x 8	375	12 x 14	71.5
8 x 12	1,500	4 x 9	333.4	12 x 16	62.5
9 x 9	1,777.9	4 x 10	300	12 x 18	55.6
10 x 10	1,600	4 x 11	272.8	12 x 20	50
9 x 11	1,455.5	4 x 12	250	16 x 18	41.8
9 x 12	1,333.4	5 x 6	400	20 x 20	30
10 x 10	1,440	5 x 7	342.10	20 x 24	25
10 x 12	1,200	5 x 8	300	22 x 24	22.8
11 x 11	1,190	5 x 9	266.8	18 x 24	27.10
11 x 12	1,091	5 x 10	540	18 x 20	33.4
12 x 12	1,000	5 x 11	218.2	14 x 16	53.7
14 x 16	642.10	5 x 12	200	15 x 18	44.5
16 x 18	500	6 x 6	333.4	16 x 20	37.6
18 x 20	400	6 x 7	285.8	13 x 14	66.11
20 x 22	327.3	6 x 8	250	30 x 40	10
22 x 24	272.8	6 x 9	222.2	36 x 36	9.3

NUMBER OF CUBIC FEET OF TIMBER IN A TON (AVOIRDUPOIS), TOGETHER WITH THE WEIGHT IN LBS. PER CUBIC FOOT.

Woods.	Lbs. per Cubic Foot.	Cubic Feet per Ton.	Woods.	Lbs. per Cubic Foot.	Cubic Feet per Ton.
Alder, dry........	50.	44.80	Larch, dry......	34.	65.8
Ash "	52.812	42.414		35.	
	43.125		Lignum vitæ......	83.312	26.866
Apple "	49.562	45.18	Logwood	57.062	39.225
Bay	43.601		Mahogany........	35.	64.
" dry...........	51.375	43.601		66.437	33.714
Beech	43.8		Maple, dry........	46.876	47.66
" dry	53.25		Oak, Canadian....	54.5	41.101
Birch, common....	43.8		" English......	58.25	38.455
" Am'can black	46.9		" live, seasoned	66.75	33.558
Box	62.5	39.40	" " green ..	78.75	
Bullet-wood.......	58.		" white upland	43.	52.09
Butternut, dry....	23.5		Pear, dry.........	41.312	
Cedar, "	35.62	63.866	Plum, "	49.062	47.47
Cork, "	15.	149.333	Poplar............	26.31	
Cherry, " ...	44.687		Pine, pitch, dry...	41.25	54.303
Chestnut, "	38.125		" red " ...	36.875	60.745
Ebony, mean of 2			" white, " ...	34.625	64.693
sets	79.4		" well seasoned	29.562	75.773
Elm, dry........	41.937	53.25	" yellow.......	33.812	66.248
	35.625	62.97	" " dry...	28.812	
Fir, white.........	35.57		Poplar, mean, 2		
Fir, New Eng., dry	34.4		sorts	28.5	
Fir, Norw'y spruce,			Rosewood, dry....	45.5	
dry	32.		Satinwood, "	55.312	
Fir, Riga.........	46.9		Spruce, "	31.25	71.68
Gum, blue, dry. .	52.687		Tamarack, "	23.937	
Hackmatack, " ...	37.10	60.37	Teak, African oak.	46.9	
Hazel, " ...	53.75		Walnut, dry.......	41.9	53.42
Hemlock, " ...	23.		" black, dry.	31.25	71.68
Hickory, pig nut..	49.5	45.252	Willow, dry.......	36.562	61.265
" shell bark	43.125	51.942	" "	30.375	73.744
Holly, dry........	47.5				
Juniper, "	35.375				
Lance wood, dry..	45.				

COMPARATIVE VALUE OF DIFFERENT WOODS, EXHIBITING THEIR CRUSHING STRENGTH AND STIFFNESS.

Teak..........	6555	Beech....	3079	Walnut	2374
English oak....	4074	Quebec oak.....	2927	Yellow pine....	2193
Ash	3571	Mahogany......	2571	Sycamore	1833
Elm	3468	Spruce.........	2522	Cedar..........	700

RELATIVE HARDNESS OF WOODS.

Taking shell bark hickory as the highest standard of our forest trees, and calling that 100, other trees will compare with it for hardness as follows:

Shell b'rk hick'ry..	100	Red oak.........	69	Wild cherry......	55
Pignut hickory...	96	White beech.....	65	Yellow pine......	54
White oak.......	84	Black walnut.....	65	Chestnut	52
White ash.......	77	Black birch......	62	Yellow poplar....	51
Dogwood.........	75	Yellow oak.......	60	Butternut........	43
Scrub oak........	73	Hard maple......	56	White birch......	43
White hazel......	72	White Elm.......	58	White pine.......	30
Apple tree.......	70	Red cedar........	56		

COMPARATIVE WEIGHT OF DIFFERENT WOODS IN GREEN AND SEASONED STATES IN POUNDS AND OUNCES PER CUB. FT.

Ash, green, 58.3; do., seasoned, 50. Beech, green, 60; do., seasoned, 50. American pine, green, 44.12; do., seasoned, 30.11. Cedar, green, 32; do., seasoned, 28.4. English oak, green, 71.10; do., seasoned, 43.8. Riga fir, green, 48.12; do.. seasoned, 35.8.

SHRINKAGE IN DIMENSIONS OF TIMBER BY SEASONING.

Woods.	Ins.	Woods.	Ins.
Pitch pine, South..	$18\frac{3}{8}$ to $18\frac{1}{4}$	Cedar, Canada	14 to $13\frac{1}{4}$
Spruce	$8\frac{1}{2}$ to $8\frac{3}{8}$	Elm..............	11 to $10\frac{3}{4}$
White pine, Am...	12 to $11\frac{7}{8}$	Oak, English......	12 to $11\frac{5}{8}$ [$9\frac{3}{4}$
Yellow pine.......	18 to $17\frac{7}{8}$	Pitch pine........	10 x 10 to $9\frac{3}{4}$ x

PERCENTAGE OF WATER IN DIFFERENT WOODS.

Alder...........	41.6	Larch	48.6	Red pine	45.2
Ash	28.7	Mountain ash...	28.3	White oak......	36.2
Birch...........	30.8	Oak............	34.7	White pine.....	37.1
Elm............	44.5	Pine	39.7	White poplar...	50.6
Horse Chestnut.	38.2	Red beech......	39.7	Willow.........	26.0

TRANSVERSE STRENGTH OF WOODS, SHOWING THEIR BREAKING WEIGHT FOR A THICKNESS OF ONE INCH SQUARE AND ONE FOOT IN LENGTH, WITH WEIGHT SUSPENDED FROM ONE END.

	Breaking Weight.	Value for Use.		Breaking Weight.	Value for Use.
	Lbs.			Lbs.	
Locust............	295	80	Oak, Canadian....	146	36
Hickory	250	55	" live, Americ'n	245	55
Oak, live, Americ'n	245	55	" English	140	35
" white "	230	50	Deal Christiana ...	137	45
" African	208	50	Pine, pitch,.......	136	45
Teak	206	60	Beech	130	32
Maple	202		Pine, white, Am...	130	45
Oak, English, best.	188	45	Elm....	125	30
Ash...............	168	55	Pine, Norway.....	123	40
Pine, American....	60	50	Oak, Dantzic......	122	30
Birch.............	160	40	White wood.......	116	38
Chestnut..........	160	53	Riga fir...........	94	30
			Pine, white.......	92	30

COHESIVE STRENGTH OF TIE-BARS, SUSPENSION RODS, ETC.

Breaking weight in tons, equal area of section of rod in square inches, multiplied by cohesive force per square inch in tons.

	Tons.		Tons.
Cohesive strength of steel =	50	Cohesive strength of Ash =	8
" " wrought iron	23	" " beech	5.5
" " cast iron	7½	" " oak	5.5
" " wrought copper	15	" " seasoned	6
" " cast brass	8	" " pitch pine	6
" " lead	0.75	" " chestnut	5
" " boxwood	10	" " fir	5.5

In use take ¼ of the above as breaking weight.

BREAKING AND CRUSHING STRAINS OF IRON AND STEEL. AVERAGE CALCULATIONS.

Breaking strain of wrought iron	= 23 tons	per	sq. inch	of section.
Crushing " "	= 17	"	"	"
Breaking strain of cast iron	= 7½	"	"	"
Crushing " "	= 50	"	"	"
Breaking strain of steel bars	= 50	"	"	"
Crushing " "	= 166	"	"	"

The following table shows weight in tons required to tear asunder bars 1 inch square of the following materials.

Oak	5⅙ tons	Wrought copper	15 tons
Fir	5¼ "	English bar iron	25 "
Cast iron	7¾ "	American iron	37½ "
Wrought iron	10 "	Blistered steel	59½ "

WEIGHT OF SQUARE AND ROUND CAST IRON.

Square per Foot.				Round per Foot.			
Size.	Weight.	Size.	Weight.	Size.	Weight.	Size.	Weight.
Inches Square.	Pounds.	Inches Square.	Pounds.	Inches Diam.	Pounds.	Inches Diam.	Pounds.
½	.78	4	50.	½	.61	4⅛	41.76
⅝	1.22	4⅛	53.14	⅝	.95	4¼	44.27
¾	1.75	4¼	56.44	¾	1.38	4⅜	46.97
⅞	2.39	4⅜	59.81	⅞	1.87	4½	49.70
1	3.12	4½	63.28	1	2.45	4⅝	52.50
1⅛	3.95	4⅝	66.84	1⅛	3.10	4¾	55.37
1¼	4.88	4¾	70.50	1¼	3.83	4⅞	58.32
1⅜	5.90	4⅞	74.26	1⅜	4.64	5	61.35
1½	7.03	5	78.12	1½	5.52	5⅛	64.46
1⅝	8.25	5⅛	82.08	1⅝	6.48	5¼	67.64
1¾	9.57	5¼	86.13	1¾	7.51	5⅜	70.09
1⅞	10.98	5⅜	90.28	1⅞	8.62	5½	74.24
2	12.50	5½	94.53	2	9.81	5⅝	77.65
2⅛	14.11	5⅝	98.87	2⅛	11.08	5¾	91.14
2¼	15.81	5¾	103.32	2¼	12.42	5⅓	84.71
2⅜	17.62	5⅞	107.86	2⅜	13.84	6	88.35
2½	19.53	6	112.50	2½	15.33	6¼	95.87
2⅝	21.53	6¼	122.08	2⅝	16.91	6½	103.69
2¾	23.63	6½	132.03	2¾	18.56	6¾	111.82
2⅞	25.83	6¾	142.38	2⅞	20.28	7	120.26
3	28.12	7	153.12	3	22.18	7¼	129.
3⅛	30.51	7¼	164.25	3⅛	23.96	7½	138.05
3¼	33.	7½	175.78	3¼	25.92	7¾	147.41
3⅜	35.59	7¾	187.68	3⅜	27.95	8	157.08
3½	38.28	8	200.12	3½	30.16	8¼	167.05
3⅝	41.06	8¼	212.56	3⅝	32.25	8½	177.19
3¾	43.94	8½	225.78	3¾	34.51	8¾	187.91
3⅞	46.92	8¾	239.25	3⅞	36.85	9	198.79
		9	253.12	4	39.27	9¼	210.

EXPANSION AND CONTRACTION OF BODIES.

The following table exhibits the linear dilatation of various bodies from 32° to 212°, according to Laplace, Smeaton, Roy, etc.

	Laplace.	Smeaton.	Petit.	Troughton	Roy.
Flint glass	1-1232	....	1-1161	......	......
Glass (barometer tubes)	1-1000	1-1200	....	......	1-1289
" solid rod	....	to	....	......	1-1237
" cast, prism of	....	1-923	....	......	1-901
Platinum, per Borda	1-1167	....	1-1131	1-1008	......
Palladium, per Wollaston	1-1000	....	....	......	......
Gold (French standard)	1-661	....	....	......	......
Silver (French standard	1-524	....	....	1-480	......
Copper 8 parts, tin 1	....	1-550	....	......	......
Copper	1-584	1-588	....	1-521	......
Copper 2, zinc 1	....	1-486	....	......	......
Brass 16, tin 1	....	1-524	....	......	......
Brass wire	....	1-517	....	......	......
Brass cast	1-535	1-533	....	......	1-528
Solder, tin 1, lead 2	....	1-399	....	......	......
Bismuth	....	1-719	....	......	......
Speculum metal	....	1-517	....	......	......
Iron	1-819	1-795	1-846	......	......
Steel (yellow temper)	1-807	1-816	....	1-840	1-874
Tin, Falmouth	1-460	1-438	....	......	......
Lead	1-351	1-349	....	......	......
Zinc	....	1-340	....	......	......
Mercury, in volume	100-5550	....	....	......	......
Water	1-23	....	....	......	......
Alcohol	1-9	....	....	......	......
All the gases	100-287	....	....	......	......

SHRINKAGE OF CASTINGS.

Iron, small cylinders .... = 1-16 inch per foot.
" pipes .... = $\frac{1}{8}$ " "
" girders, beams, etc. .... = $\frac{1}{8}$ in. in 15 inches.
" large cylinders, the contraction of diameter at top .... = 1-16 per foot.
" do. do. at bottom.... = 1-12 " "
" do. do. in length.... = $\frac{1}{8}$ in 16 inches.
Brass, thin .... = $\frac{1}{8}$ in 9 "
" thick .... = $\frac{1}{8}$ in

Zinc	=5-16 in a foot.
Lead	=5-16 " "
Copper	=3-16 " "
Bismuth	=5-32 " "

Green sand iron castings are 6 per cent. stronger than dry, and 30 per cent. stronger than chilled, but when the castings are chilled and annealed, a gain of 115 per cent. is attained over those made in green sand. Chilling the under side of cast iron very materially increases its strength.

LINEAL EXPANSION OF METALS.

Produced by raising their temperature from 32° to 212° Fahrenheit.

Zinc	1 part in 322	Gold	1 part in 682
Platinum	" 351	Bismuth	" 719
Tin (pure)	" 403	Iron	" 812
Tin (impure)	" 500	Antimony	" 923
Silver	" 524	Palladium	" 1000
Copper	" 581	Platinum	" 1100
Brass	" 584	Flint glass	" 1248
Falmouth tin	" 462	Soft rolled iron	" 819
English brass rod	" 528	Prism of cast iron	" 901
Brass wire	" 517	Reflector metal	" 517
Blistered steel	" 870	Refined silver	" 528

TENSILE STRENGTH OF MATERIALS, SHOWING THE STRENGTH OR FORCE REQUIRED TO TEAR ASUNDER 1 SQUARE INCH.

	Lbs.		Lbs.
Iron wire, wrought	103,000	Cast steel, maximum	142,000
Swedish bar iron	72,000	" " mean	88,000
Russian " "	59,500	Steel	100,000 to 130,000
Mean of English iron	53,900	Chrome steel, mean	170,980
Gun metal, mean of iron	37,232	Shear "	124,000
Clyde, No. 1, "	16,125	American Tool Co.	179,980
" " 2, "	23,468	Blistered steel, soft	133,000 104,000
Stirling, mean of "	25,764		
American, mean of "	45,970	Razor "	15,000
Low Moor, No. 2, cast "	14,076	Steel plates, lengthwise	96,300
Crank shaft "	44,750	" " crosswise	93,700
American boiler plates, iron	48,000 62,000	Yellow metal	48,700
		Cast copper	19,000
English plates mean	51,000	American copper	24,250
" " lengthwise	53,800	Brass wire	50,000
" " crosswise	48,800	Copper bolts	38,000
German piano steel wire	268,800	" wire	60,000

TENSILE STRENGTH OF MATERIALS, ETC. (*Continued*).

	Lbs.		Lbs
Brass	42,000	Wire rope	37,000
Gold	20,490	Whalebone	7,600
Gold, 5 pts., copper, 1 pt.	50,000	Leather belting	333
Silver cast	40,997	Gutta-percha	3,500
Bronze	17,698 to 56,788	Slate	12,000
Tin cast, block	5,000	Well-burned brick	750
" banca	2,122	Inferior "	100 to 290
Platinum wire	5,300	Portland stone	857 to 1,000
Zinc	7,000	Crown glass	42,346
Sheet lead	3,000	Limestone	670 to 2,800
Antimony	1,060	Hydraulic lime	140
Bismuth, cast	3,120	" cement	234
Ivory	16,070	Portland " 6 mos.	414
Manilla rope	9,300	Plaster-of-Paris	72
Tarred hemp rope	15,000		

REMARKS.—Owing to the damage inflicted by the hot tar, tarred ropes are 25 per cent. weaker than white ropes. Hemp rope is stronger than Manilla, but tarred hemp and Manilla are nearly of equal strength. Manilla ropes are from 25 to 30 per cent. weaker than white ropes. Twisted hempen cords will sustain the following weights per square inch of their section: ¼ inch to 1 inch thick, 8,746 lbs.; 1 to 3 ins. thick, 6,860 lbs.; 3 to 5 ins. thick, 5,342 lbs.; 5 to 7 ins. thick, 4,860 lbs. Ropes of four strands, up to 8 ins., are about 17 per cent. stronger than those having but three strands.

Mensuration of Superficies.

TO FIND THE AREA OF A SQUARE.

Rule.—Multiply the side by itself, or in other words, the base by the perpendicular.

Example.—To find the area of a square whose side is 17 feet. $17 \times 17 = 289$, the area of the square in feet.

To find the side of a square, the area being given, extract the square root of the area.

TO FIND THE AREA OF A RECTANGLE.

Rule.—Multiply the length by the breadth, and the product will be the area.

Example.—To find the area of the rectangle.

ft. in.	
10.7	its length.
7.3	breadth.
74.1	
2.7.9	
Feet, 76.8.9	

TO FIND THE AREA OF A RHOMBUS OR RHOMBOIDES.

Rule.—Multiply the base by the perpendicular height and half the product will be the area.

Multiply the length by the perpendicular breadth, and the product will be the area.

Let the side be 17 feet, and the perpendicular 15 feet, then

$$17 \times 15 = 255, \text{ the area required.}$$

TO FIND THE AREA OF A TRIANGLE.

Rule.—Multiply the base by the perpendicular height, and half the product will be the area. Let the base of the triangle be 14 feet and the perpendicular height 9 feet, then

$$14 \times 9 = 126 \div 2 = 63 \text{ feet the area of the triangle.}$$

Another Rule.—Add the three sides together, and from half the sum subtract each side separately; then multiply the half sum and the three sides together, and the square root of the product will the area required.

Let the sides of a triangle be 30, 40, and 50 ft. respectively.

$$\frac{30 + 40 + 50}{2} = \frac{120}{} = 60, \text{ half the sum of the sides.}$$

$$60 - 50 = 10, \text{ first remainder.}$$

$$60 - 40 = 20, \text{ second remainder.}$$

$$60 - 30 = 30, \text{ third remainder.}$$

$$\text{Then } 60 \times 10 \times 20, \times 30 = 360{,}000.$$

And the square root of 360,000 is equal to 600, the area in ft.

ANY TWO SIDES OF A RIGHT-ANGLED TRIANGLE BEING GIVEN, TO FIND THE THIRD SIDE.

1. When the base and perpendicular are given.

Rule.—To the square of the base add the square of the perpendicular, and the square root of the sum will give the hypothenuse.

Let the base of the right-angled triangle be 24, and the perpendicular 18, to find the hypothenuse or third side.

576 square of the base.
324 square of the perpendicular.

$$576 + 324 = 900.$$

And the square root of 900 is equal to 30 feet, the length of the third side.

2. When the hypothenuse and one side is given.

Rule.—Multiply the sum of the hypothenuse and one side by their difference; the square root of the product will give the other side.

If the hypothenuse of a right-angled triangle be 30, and the perpendicular 18, what will be the base?

$30 + 18 = 48$ sum of the two sides.
$30 - 18 = 12$ difference of the two sides.
$48 \times 12 = 576.$

TO FIND THE AREA OF A TRAPEZIUM.

Rule.—Divide the trapezium into two triangles by a diagonal drawn from one angle of the figure to another. The areas of the triangles may be found by the rules already given, and the sum will give the area of the trapezium. It is unnecessary to give an example of this problem, as it would only be a repetition of what has been already illlustrated.

IRREGULAR POLYGONS, OR MANY-SIDED FIGURES.

It is only necessary to reduce them into triangles and

parallelograms, and, calculating these severally, to add them together; the sum will give the area of the figure.

In this manner the land-surveyor estimates the quantity of acres, roods and perches contained within certain boundaries, and it may be done with considerable accuracy by subdividing the space until the whole area is contained within a number of single figures. The architectural surveyor, however, has seldom a necessity for this mode of proceeding, for it is customary, in all those cases where a surface has a variable height, to take the medium between the two extremes, and consider the superficies as a parallelogram. But, as the builder is sometimes required by circumstances to measure the ground which is chosen as the site of a building, it is necessary that he should be able to do so when required.

TO FIND THE DIAMETER OR CIRCUMFERENCE OF A CIRCLE, THE DIAMETER OR CIRCUMFERENCE BEING GIVEN.

1. To find the circumference, the diameter being given.

Rule.—As 7 is to 22, so is the diameter to the circumference.

Example.—If the diameter of a circle be 84.5 inches, what is the circumference?

As 7 is to 22.0, so is 84.5 to 265,751 the circumference required.

2. To find the diameter, the circumference being given.

Rule.—As 22 is to 7, so is the circumference to the diameter.

TO FIND THE AREA OF A CIRCLE.

1. When the diameter and circumference are both given.

Rule.—Multiply half the circumference by half the diameter, and the product will be the area.

2. When the diameter is given.

Rule.—Multiply the square of the diameter by .7854, and the product will be the area, or the diameter by the circumference and divide by 4.

3. When the circumference is given.

Rule.—Multiply the square of the circumference by .07958, and the product will be the area.

TO FIND THE AREA OF A SECTOR OF A CIRCLE.

Rule.—Multiply the radius of the circle by one-half of the arc of the sector.

TO FIND THE AREA OF THE SEGMENT OF A CIRCLE.

Rule.—Find the area of a circle having the same arc, and deduct the triangle formed between the two radii and the chord of the arc.

PROPERTIES OF THE CIRCLE.

Diameter	$\times$ 3.14159	= circumference.
Diameter	$\times$ .8862	= side of an equal square.
Diameter	$\times$ .7071	= side of an inscribed square.
Radius squared	$\times$ .314159	= area of circle.
Radius	$\times$ 6.28318	= circumference.
Circumference	$\div$ 3.14159	= diameter.

Measurements of Solids.

TO FIND THE SOLIDITY OF A CUBE.

A cube is a solid enclosed by six equal square surfaces.

Rule.—Multiply the side of the square by itself and that product by the side of the square.

Example.—The side being 9 feet.

$$9 \times 9 = 81 \text{ then.}$$
$$81 \times 9 = 729 = \text{the solidity required.}$$

TO FIND THE SOLIDITY OF A PARALLELOPIPEDON.

A parallelopipedon is a solid having six sides. Every opposite two being equal and parallel to each other.

Rule.—Multiply the length by the breadth, and the product by the depth, and it will give the solidity required.

Example.—Length 82 inches, breadth 54, depth 10 inches.

$$82 \times 54 = 4428, \text{ then}$$
$$4428 \times 10 = 44280, \text{ the solidity required.}$$

TO FIND THE SOLIDITY OF A PRISM.

A prism is a solid, the ends of which are parallel, equal, and of the same figure. Specific names are given to them, according to the form of their bases or ends.

Rule.—Multiply the area of the base by the perpendicular height, and the product will be the solidity required.

To find the solidity of a rectangular prism whose base is 30 inches, and height 53.

$$30 \times 53 = 1590, \text{ the solidity in inches.}$$

TO FIND THE SOLIDITY OF A CYLINDER.

A cylinder is a round prism, having circles for its ends, and is formed by the revolution of a right line about the circumference of two equal circles parallel to each other.

Rule.—Multiply the area of the base by the perpendicular height of the cylinder, and it will give the solidity.

TO FIND THE SOLIDITY OF A SPHERE.

A sphere is a solid formed by the revolution of a semicircle round a fixed diameter.

Rule.—Multiply the cube of the diameter by .5236, and the product will be the solidity.

FOR THE AREA OF A SPHERE.

Multiply the square of the diameter by 3.1416.

FOR THE CIRCUMFERENCE.

Multiply the diameter by 3'.416.

The surface of a *spherical segment* or zone may be found by multiplying the diameter by the height, and then by 3'1416.

The solidity of a *spherical segment* or zone may be found thus—to 3 times the square of the radius (or half of the diameter) add the square of the height, then multiply the sum by the height and the product by .5236.

REGULAR POLYGONS.

Nnmber of Sides.	Name.	Area when diam. of inscribed circle = 1.	Area when side = 1.	Length of side when perpendicular = 1.	Perpendicular when side = 1.	Radius of circumscribed circle when side = 1.	Length of side when radius of circumscribed circle = 1.
3	Triangle.....	1.299	0.433	3.464	0.289	.577	1.732
4	Square	1.000	1.000	2.000	0.500	.707	1.414
5	Pentagon.....	.908	1.720	1.453	0.688	.851	1.176
6	Hexagon.....	.866	2.508	1.555	0.866	1.000	1.000
7	Heptagon....	.843	3.634	.963	1.039	1.152	.868
8	Octagon	.828	4.828	.828	1.207	1.307	.765
9	Nonagon	.819	6.182	.728	1.374	1.462	.684
10	Decagon......	.812	7.694	.650	1.539	1.618	.618
11	Undecagon ..	807	9.366	.587			

AREA OF POLYGONS.

Rule.—Multiply the square of the side by the figures in column 2.

Trigon..........................	3 sides	0.4330
Pentagon........................	5 sides	1.7203
Hexagon	6 sides	2.5981
Heptagon	7 sides	3.6339
Octagon.........................	8 sides	4.8284
Nonagon	9 sides	6.1818
Decagon	10 sides	7.6942
Undecagon......................	11 sides	9.3656
Dodecagon......................	12 sides	11.1962

SURFACES AND SOLIDITIES OF REGULAR BODIES.

Rule.—For the "surface" multiply the square of the length of one of the edges by column 2, and for the solidity multiply the cube of the length by column 3.

		Surface.	Solidity.
Tetraedron..............	4 faces	1.7321	0.1178
Hexaedron..............	6 "	6.0000	1.0000
Octaedron................	8 "	3.4641	0.4714
Dodecaedron............	12 "	20.6458	7.6631
Icasaedron..............	20 "	8.6603	2.1817

NUMBER FOR CALCULATING AREAS.

Circum. of circle = Diam. × 3.1416, or by 3 1-7th.

Length of arc of circle = Take span from 8 times the chord of half the arc and one-third remainder = length of arc required.

Ditto when arc contains 120° = Span × 1.2092.

Area of circle = Square of diam. × .7854.

Area of segment of circle = To twice square root of span *plus* square of rise *add* chord of half arc, the result *multiplied* by 4-15 of rise equals area.

Area when it contains 120° = Square of span × .20473.

Area of sector of circle = Radius × half the length of arc.

Area of ellipse = Product of the two diameters × .7834.

Area egg-shaped sewer = Square of transverse diameter × 1.1597.

Solidity of a cone = Area of base × one-third perpendicular height.

Solidity of globe = Cube of diameter × .5236.

Prismoidal formula = Sum of end areas *plus* 4 times middle area multiplied by one-sixth of length.

NOTE.—The prismoidal formula applies to earthworks, casks, and truncated cones.

GUNTER'S CHAIN.

Generally adopted in land surveying, is 22 yards in length,

or 100 links of 7.92 inches long. The length was fixed at 22 yards because the square whose side is 22 contains exactly 1-10th of an acre—or 1 chain in width and 10 in length contains an acre; 80 chains make 1 mile, and a square mile is the square of 80, or 640 acres.

TABLE OF SPHERICAL CONTENTS.

Diameters	Surfaces.	Capacities.
1	3.141	.523
2	12.567	4.188
3	28.274	14.137
4	50.265	33.51
5	78.540	65.45
10	314.159	523.6
15	706.9	1767.1
20	1256.6	4189.
25	1963.5	8181.
30	2827.	14137.
40	5026.	33510.

SQUARES AND CUBES OF NUMBERS.

Number.	Square.	Cube.	Number.	Square.	Cube.
1	1	1	23	529	12167
2	4	8	24	576	13824
3	9	27	25	625	15625
4	16	64	26	676	17576
5	25	125	27	729	19683
6	36	216	28	784	21952
7	49	343	29	841	24389
8	64	512	30	900	27000
9	81	769	31	961	29791
10	100	1000	32	1024	32768
11	121	1331	33	1089	35937
12	144	1728	34	1156	39304
13	169	2197	35	1225	42875
14	196	2744	36	1296	46656
15	225	3375	37	1369	50653
16	256	4096	38	1444	54872
17	289	4913	39	1521	59319
18	324	5832	40	1600	64000
19	361	6859	41	1681	68921
20	400	8000	42	1764	74088
21	441	9261	43	1849	79507
22	484	10648	44	1936	85184

SQUARES AND CUBES OF NUMBERS (*Continued*).

Number.	Square.	Cube.	Number.	Square.	Cube.
45	2025	91125	90	8100	729000
46	2116	97336	91	8281	753571
47	2209	103823	92	8464	778688
48	2304	110592	93	8649	804357
49	2401	117649	94	8836	830584
50	2500	125000	95	9025	857375
51	2601	132651	96	9216	884736
52	2704	140608	97	9409	912673
53	2809	148877	98	9604	941192
54	2916	157464	99	9801	970299
55	3025	166375	100	10000	1000000
56	3136	175616	101	10201	1030301
57	3249	185193	102	10404	1061208
58	3364	195112	103	10609	1092727
59	3481	205379	104	10816	1124864
60	3600	216000	105	11025	1157625
61	3721	226981	106	11236	1191016
62	3844	238328	107	11449	1225043
63	3969	250047	108	11664	1259712
64	4096	262144	109	11881	1295029
65	4225	274625	110	12100	1331000
66	4356	287496	111	12321	1367631
67	4489	300763	112	12544	1404928
68	4624	314432	113	12769	1442897
69	4761	328509	114	12996	1481544
70	4900	343000	115	13225	1520875
71	5041	357911	116	13456	1560896
72	5184	373248	117	13689	1601613
73	5329	389017	118	13924	1643032
74	5476	405224	119	14161	1685159
75	5625	421875	120	14400	1728000
76	5776	438976	121	14641	1771561
77	5929	456533	122	14884	1815848
78	6084	474552	123	15129	1860867
79	6241	493039	124	15376	1906624
80	6400	512000	125	15625	1953125
81	6561	531441	126	15876	2000376
82	6724	551368	127	16129	2048383
83	6389	571787	128	16384	2097152
84	7056	592704	129	16641	2146689
85	7225	614125	130	16900	2197000
86	7396	636056	131	17161	2248091
87	7569	658503	132	17424	2299968
88	7744	681472	133	17689	2352637
89	7921	704969	134	17956	2406104

SQUARES AND CUBES OF NUMBERS (*Continued*).

Number.	Square.	Cube.	Number.	Square.	Cube.
135	18225	2460375	180	32400	5832000
136	18496	2515456	181	32761	5929741
137	18769	2571353	182	33124	6028568
138	19044	2628072	183	33489	6128487
139	19321	2685619	184	33856	6229504
140	19600	2744000	185	34225	6331625
141	19881	2803221	186	34596	6434856
142	20164	2863288	187	34969	6539203
143	20449	2924207	188	35344	6644672
144	20736	2985984	189	35721	6751269
145	21025	3048625	190	36100	6859000
146	21316	3112136	191	36481	6967871
147	21609	3176523	192	36864	7077888
148	21904	3241792	193	37249	7189057
149	22201	3307949	194	37636	7301384
150	22500	3375000	195	38025	7414875
151	22801	3442951	196	38416	7529536
152	23104	3511808	197	38809	7645373
153	23409	3581577	198	39204	7762392
154	23716	3652264	199	39601	7880599
155	24025	3723875	200	40000	8000000
156	24336	3796416	201	40401	8120601
157	24649	3869893	202	40804	8242408
158	24964	3944312	203	41209	8365427
159	25281	4019679	204	41616	8489664
160	25600	4096000	205	42025	8615125
161	25921	4173281	206	42436	8741816
162	26244	4251528	207	42849	8869743
163	26569	4330747	208	43264	8998912
164	26896	4410944	209	43681	9129329
165	26225	4492125	210	44100	9261000
166	27556	4574296	211	44521	9393931
167	27889	4657463	212	44944	9528128
168	28224	4741632	213	45369	9663597
169	28561	4826809	214	45796	9800344
170	28900	4913000	215	46225	9938375
171	29241	5000211	216	46656	10077696
172	29584	5088448	217	47089	10218313
173	29929	5177717	218	47524	10360232
174	30276	5268024	219	47961	10503459
175	30625	5359375	220	48400	10648000
176	30976	5451776	221	48841	10793861
177	31329	5545233	222	49284	10941048
178	31684	5639752	223	49729	11089567
179	32041	5735339	224	50176	11239424

SQUARES AND CUBES OF NUMBERS (*Continued*).

Number.	Square.	Cube.	Number.	Square.	Cube.
225	50625	11390625	270	72900	19683000
226	51076	11543176	271	73441	19902511
227	51529	11697083	272	73984	20123648
228	51984	11852352	273	74529	20346417
229	52441	12008989	274	75076	20570824
230	52900	12167000	275	75625	20796875
231	53361	12326391	276	76176	21024576
232	53824	12487168	277	76729	21253933
233	54289	12649337	278	77284	21484952
234	54756	12812904	279	77841	21717639
235	55225	12977875	280	78400	21952000
236	55696	13144256	281	78961	22188041
237	56169	13312053	282	79524	22425768
238	56644	13481272	283	80089	22665187
239	57121	13651919	284	80656	22906304
240	57600	13824000	285	81225	23149125
241	58081	13994521	286	81796	23393656
242	58564	14172488	287	82369	23639903
243	59049	14348907	288	82944	23887872
244	59536	14526784	289	83521	24137569
245	60025	14706125	290	84100	24389000
246	60516	14886936	291	84681	24642171
247	61009	15069223	292	85264	24897088
248	61504	15252992	293	85849	25153757
249	62001	15438249	294	86436	25412184
250	62500	15625000	295	87025	25672375
251	63001	15813251	296	87616	25934336
252	63504	16003008	297	88209	26198073
253	64009	16194277	298	88804	26463592
254	64516	16387064	299	89401	26730899
255	65025	16581375	300	90000	27000000
256	65536	16777216	301	90601	27270901
257	66049	16974593	302	91204	27543608
258	66564	17173512	303	91809	27818127
259	67081	17373979	304	92416	28094464
260	67600	17576000	305	93025	28372625
261	68121	17779581	306	93636	28652616
262	68644	17984728	307	94249	28934443
263	69169	18191447	308	94864	29218112
264	69696	18399744	309	95481	29503629
265	70225	18609625	310	96100	29791000
266	70756	18821096	311	96721	30080231
267	71289	19034163	312	97344	30371328
268	71824	19248832	313	97969	30664297
269	72361	19465109	314	98596	30959144

SQUARES AND CUBES OF NUMBERS (*Continued*).

Number.	Square.	Cube.	Number.	Square.	Cube.
315	99225	31255875	360	129600	46656000
316	99856	31554496	361	130321	47045881
317	100489	31855013	362	131044	47437928
318	101124	32157432	363	131769	47832147
319	101761	32461759	364	132496	48228544
320	102400	32768000	365	133225	48627125
321	103041	33076161	366	133956	49027896
322	103684	33386248	367	134689	49430863
323	104329	33698267	368	135424	49836032
324	104976	34012224	369	136161	50243409
325	105625	34328125	370	136900	50653000
326	106276	34645976	371	137641	51064811
327	106929	34965783	372	138384	51478848
328	107584	35287552	373	139129	51895117
329	108241	35611289	374	139876	52313624
330	108900	35937000	375	140625	52734375
331	109561	36264691	376	141376	53157376
332	110224	36594368	377	142129	53582633
333	110889	36926037	378	142884	54010152
334	111556	37259704	379	143641	54439939
335	112225	37595375	380	144400	54872000
336	112896	37933056	381	145161	55306341
337	113569	38272753	382	145924	55742968
338	114244	38614472	383	146689	56181887
339	114921	38958219	384	147456	56623104
340	115600	39304000	385	148225	57066625
341	116281	39651821	386	148996	57512456
342	116964	40001688	387	149769	57960603
343	117649	40353607	388	150544	58411072
344	118336	40707584	389	151321	58863869
345	119025	41063625	390	152100	59319000
346	119716	41421736	391	152881	59776471
347	120409	41781923	392	153664	60236288
348	121104	42144192	393	154449	60698457
349	121801	42508549	394	155236	61162984
350	122500	42875000	395	156025	61629875
351	123201	43243551	396	156816	62099136
352	123904	43614208	397	157609	62570773
353	124609	43986977	398	158404	63044792
354	125316	44361864	399	159201	63521199
355	126025	44738875	400	160000	64000000
356	126736	45118016	401	160801	64481201
357	127449	45499293	402	161604	64964808
358	128164	45882712	403	162409	65450827
359	128881	46268279	404	163216	65939264

SQUARES AND CUBES OF NUMBERS (*Continued*).

Number.	Square.	Cube.	Number.	Square.	Cube.
405	164025	66430125	450	202500	91125000
406	164836	66923416	451	203401	91733851
407	165649	67419143	452	204304	92345408
408	166464	67917312	453	205209	92959677
409	167281	68417929	454	206116	93576664
410	168100	68921000	455	207025	94196375
411	168921	69426531	456	207936	94818816
412	169744	69934528	457	208849	95443993
413	170569	70444997	458	209764	96071912
414	171396	70951944	459	210681	96702579
415	172225	71473375	460	211600	97336000
416	173056	71991296	461	212521	97972181
417	173889	72511713	462	213444	98611128
418	174724	73034632	463	214369	99252847
419	175561	73560059	464	215296	99897344
420	176400	74088000	465	216225	100544625
421	177241	74618461	466	217156	101194696
422	178084	75151448	467	218089	101847563
423	178929	75686967	468	219024	102503232
424	179776	76225024	469	219961	103161709
425	180625	76765625	470	220900	103823000
426	181476	77308776	471	221841	104487111
427	182329	77854483	472	222784	105154048
428	183184	78402752	473	223729	105823817
429	184041	78953589	474	224676	106496424
430	184900	79507000	475	225625	107171875
431	185761	80062991	476	226576	107850176
432	186624	80621568	477	227529	108531333
433	187489	81182737	478	228484	109215352
434	188356	81746504	479	229441	109902239
435	189225	82312875	480	230400	110592000
436	190096	82881856	481	231361	111284641
437	190969	83453453	482	232324	111980168
438	191844	84027672	483	233289	112678587
439	192721	84604519	484	234256	113379904
440	193600	85184000	485	235225	114084125
441	194481	85766121	486	236196	114791256
442	195364	86350888	487	237169	115501303
443	196249	86938307	488	238144	116214272
444	197136	87528384	489	239121	116930169
445	198025	88121125	490	240100	117649000
446	198916	88716536	491	241081	118370771
447	199809	89314623	492	242064	119095488
448	200704	89915392	493	243049	119823157
449	201601	90518849	494	244036	120553784

SQUARES AND CUBES OF NUMBERS (*Continued*).

Number.	Square.	Cube.	Number.	Square.	Cube.
495	245025	121287375	540	291600	157464000
496	246016	122023936	541	292681	158340421
497	247009	122763473	542	293764	159220088
498	248004	123505992	543	294849	160103007
499	249001	124251499	544	295936	160989184
500	250000	125000000	545	297025	161878625
501	251001	125751501	546	298116	162771336
502	252004	126506008	547	299209	163667323
503	253009	127263527	548	300304	164566592
504	254016	128024064	549	301401	165469149
505	255025	128787625	550	302500	166375000
506	256036	129554216	551	303601	167284151
507	257049	130323843	552	304704	168196608
508	258064	131096512	553	305809	169112377
509	259081	131872229	554	306916	170031464
510	260100	132651000	555	308025	170953875
511	261121	133432831	556	309136	171879616
512	262144	134217728	557	310249	172808693
513	263169	135005697	558	311364	173741112
514	264196	135796744	559	312481	174676879
515	265225	136590875	560	313600	175616000
516	266256	137388096	561	314721	176558481
517	267289	138188413	562	315844	177504328
518	268324	138991832	563	316969	178453547
519	269361	139798359	564	318096	179406144
520	270400	140608000	565	319225	180362125
521	271441	141420761	566	320356	181321496
522	272484	142236648	567	321489	182284263
523	273529	143055667	568	322624	183250432
524	274576	143877824	569	323761	184220009
525	275625	144703125	570	324900	185193000
526	276676	145531576	571	326041	186169411
527	277729	146363183	572	327184	187149248
528	278784	147197952	573	328329	188132517
529	279841	148035889	574	329476	189119224
530	280900	148877000	575	330625	190109375
531	281961	149721291	576	331776	191102976
532	283024	150568768	577	332929	192100033
533	284089	151419437	578	334084	193100552
534	285156	152273304	579	335241	194104539
535	286225	153130375	580	336400	195112000
536	287296	153990656	581	337561	196122941
537	288369	154854153	582	338724	197137368
538	289444	155720872	583	339889	198155287
539	290521	156590819	584	341056	199176704

SQUARES AND CUBES OF NUMBERS (*Continued*).

Number.	Square.	Cube.	Number.	Square.	Cube.
585	342225	200201625	630	396900	250047000
586	343396	201230056	631	398161	251239591
587	344569	202262003	632	399424	252435968
588	345744	203297472	633	400689	253636137
589	346921	204336469	634	401956	254840104
590	348100	205379000	635	403225	256047875
591	349281	206425071	636	404496	257259456
592	350464	207474688	637	405769	258474853
593	351649	208527857	638	407044	259694072
594	352836	209584584	639	408321	260917119
595	354025	210644875	640	409600	262144000
596	355216	211708736	641	410881	263374721
597	356409	212776173	642	412164	264609288
598	357604	213847192	643	413449	265847707
599	358801	214921799	644	414736	267089984
600	360000	216000000	645	416025	268336125
601	361201	217081801	646	417316	269586136
602	362404	218167208	647	418609	270840023
603	363609	219256227	648	419904	272097792
604	364816	220348864	649	421201	273359449
605	366025	221445125	650	422500	274625000
606	367236	222545016	651	423801	275894451
607	368449	223648543	652	425104	277167808
608	369664	224755712	653	426409	278445077
609	370881	225866529	654	427716	279726264
610	372100	226981000	655	429025	281011375
611	373321	228099131	656	430336	282300416
612	374544	229220928	657	431649	283593393
613	375769	230346397	658	432964	284890312
614	376996	231475544	659	434281	286191179
615	378225	232608375	660	435600	287496000
616	379456	233744896	661	436921	288804781
617	380689	234885113	662	438244	290117528
618	381924	236029032	663	439569	291434247
619	383161	237176659	664	440896	292754944
620	384400	238328000	665	442225	294079625
621	385641	239483061	666	443556	295408296
622	386884	240641848	667	444889	296740963
623	388129	241804367	668	446224	293077632
624	389376	242970624	669	447561	299418309
625	390625	244140625	670	448900	300763000
626	391876	245314376	671	450241	302111711
627	393129	246491883	672	451584	303464448
628	394384	247673152	673	452929	304821217
629	395641	248858189	674	454276	306182024

SQUARES AND CUBES OF NUMBERS (*Continued*).

Number.	Square.	Cube.	Number.	Square.	Cube.
675	455625	307546875	720	518400	373248000
676	456976	308915776	721	519841	374805361
677	458329	310288733	722	521284	376367048
678	459684	311665752	723	522729	377933067
679	461041	313046839	724	524176	379503424
680	462400	314432000	725	525625	381078125
681	463761	315821241	726	527076	382657176
682	465124	317214568	727	528529	384240583
683	466489	318611987	728	529984	385828352
684	467856	320013504	729	531441	387420489
685	469225	321419125	730	532900	389017000
686	470596	322828856	731	534361	390617891
687	471969	324242703	732	535824	392223168
688	473344	325660672	733	537289	393832837
689	474721	327082769	734	538756	395446904
690	476100	328509000	735	540225	397065375
691	477481	329939371	736	541696	398688256
692	478864	331373888	737	543169	400315553
693	480249	332812557	738	544644	401947272
694	481636	334255384	739	546121	403583419
695	483025	335702375	740	547600	405224000
696	484416	337153536	741	549081	406869021
697	485809	338608873	742	550564	408518488
698	487204	340068392	743	552049	410172407
699	488601	341532099	744	553536	411830784
700	490000	343000000	745	555025	413493625
701	491401	344472101	746	556516	415160936
702	492804	345948408	747	558009	416832723
703	494209	347428927	748	559504	418508992
704	495616	348913664	749	561001	420189749
705	497025	350402625	750	562500	421875000
706	498436	351895816	751	564001	423564751
707	499849	353393243	752	565504	425259008
708	501264	354894912	753	567009	426957777
709	502681	356400829	754	568516	428661064
710	504100	357911000	755	570025	430368875
711	505521	359425431	756	571536	432081216
712	506944	360944128	757	573049	433798093
713	508369	362467097	758	574564	435519512
714	509796	363994344	759	576081	437245479
715	511225	365525875	760	577600	438976000
716	512656	367061696	761	579121	440711081
717	514089	368601813	762	580644	442450728
718	515524	370146232	763	582169	444194947
719	516961	371694959	764	583696	445943744

SQUARES AND CUBES OF NUMBERS (*Continued*).

Number.	Square.	Cube.	Number.	Square.	Cube.
765	585225	447697125	810	656100	531441000
766	586756	449455096	811	657721	533411731
767	588289	451217663	812	659344	535387328
768	589824	452984832	813	660969	537367797
769	591361	454756609	814	662596	539353144
770	592900	456533000	815	664225	541343375
771	594441	458314011	816	665856	543338496
772	595984	460099648	817	667489	545338513
773	597529	461889917	818	669124	547343432
774	599076	463684824	819	670761	549353259
775	600625	465484375	820	672400	551368000
776	602176	467288576	821	674041	553387661
777	603729	469097433	822	675684	555412248
778	605284	470910952	823	677329	557441767
779	606841	472729139	824	678976	559476224
780	608400	474552000	825	680625	561515625
781	609961	476379541	826	682276	563559976
782	611524	478211768	827	683929	565609283
783	613089	480048687	828	685584	567663552
784	614656	481890304	829	687241	569722789
785	616225	483736625	830	688900	571787000
786	617796	485587656	831	690561	573856191
787	619369	487443403	832	692224	575930368
788	620944	489303872	833	693889	578009537
789	622521	491169069	834	695556	580093704
790	624100	493039000	835	697225	582182875
791	625681	494913671	836	698896	584277056
792	627264	496793088	837	700569	586376253
793	628849	498677257	838	702244	588480472
794	630436	500566184	839	703921	590589719
795	632025	502459875	840	705600	592704000
796	633616	504358336	841	707281	594823321
797	635209	506261573	842	708964	596947688
798	636804	508169592	843	710649	599077107
799	638401	510082399	844	712336	601211584
800	640000	512000000	845	714025	603351125
801	641601	513922401	846	715716	605495736
802	643204	515849608	847	717409	607645423
803	644809	517781627	848	719104	609800192
804	646416	519718464	849	720801	611960049
805	648025	521660125	850	722500	614125000
806	649636	523606616	851	724201	616295051
807	651249	525557943	852	725904	618470208
808	652864	527514112	853	727609	620650477
809	654481	529475129	854	729316	622835864

SQUARES AND CUBES OF NUMBERS (*Continued*).

Number.	Square.	Cube.	Number.	Square.	Cube.
855	731025	625026375	900	810000	729000000
856	732736	627222016	901	811801	731432701
857	734449	629422793	902	813604	733870808
858	736164	631628712	903	815409	736314327
859	737881	633839779	904	817216	738763264
860	739600	636056000	905	819025	741217625
861	741321	638277381	906	820836	743677416
862	743044	640503928	907	822649	746142643
863	744769	642735647	908	824464	748613312
864	746496	644972544	909	826281	751089429
865	748225	647214625	910	828100	753571000
866	749956	649461896	911	829921	756058031
867	751689	651714363	912	831744	758550528
868	753424	653972032	913	833569	761048497
869	755161	656234909	914	835396	763551944
870	756900	658503000	915	837225	766060875
871	758641	660776311	916	839056	768575296
872	760384	663054848	917	840889	771095213
873	762129	665338617	918	842724	773620632
874	763876	667627624	919	844561	776151559
875	765625	669921875	920	846400	778688000
876	767376	672221376	921	848241	781229961
877	769129	674526133	922	850084	783777448
878	770884	676836152	923	851929	786330467
879	772641	679151439	924	853776	788889024
880	774400	681472000	925	855625	791453125
881	776161	683797841	926	857476	794022776
882	777924	686128968	927	859329	796597983
883	779689	688465387	928	861184	799178752
884	781456	690807104	929	863041	801765089
885	783225	693154125	930	864900	804357000
886	784996	695506456	931	866761	806954491
887	786769	697864103	932	868624	809557568
888	788544	700227072	933	870489	812166237
889	790321	702595369	934	872356	814780504
890	792100	704969000	935	874225	817400375
891	793881	707347971	936	876096	820025856
892	795664	709732288	937	877969	822656953
893	797449	712121957	938	879844	825293672
894	799236	714516984	939	881721	827936019
895	801025	716917375	940	883600	830584000
896	802816	719323136	941	885481	833237621
897	804609	721734273	942	887364	835896888
898	806404	724150792	943	889249	838561807
899	808201	726572699	944	891136	841232384

SQUARES AND CUBES OF NUMBERS (*Continued*).

Number.	Square.	Cube.	Number.	Square.	Cube.
945	893025	843908625	973	946729	921167317
946	894916	846590536	974	948676	924010424
947	896809	849278123	975	950625	926859375
948	898704	851971392	976	952576	929714176
949	900601	854670349	977	954529	932574833
950	902500	857375000	978	956484	935441352
951	904401	860085351	979	958441	938313739
952	906304	862801408	980	960400	941192000
953	908209	865523177	981	962361	944076141
954	910116	868250664	982	964324	946966168
955	912025	870983875	983	966289	949862087
956	913936	873722816	984	968256	952763904
957	915849	876467493	985	970225	955671625
958	917764	879217912	986	972196	958585256
959	919681	881974079	987	974169	961504803
960	921600	884736000	988	976144	964430272
961	923521	887503681	989	978121	967361669
962	925444	890277128	990	980100	970299000
963	927369	893056347	991	982081	973242271
964	929296	895841344	992	984064	976191488
965	931225	898632125	993	986049	979146657
966	933156	901428696	994	988036	982107784
967	935089	904231063	995	990025	985074875
968	937024	907039232	996	992016	988047936
969	938961	909853209	997	994009	991026973
970	940900	912673000	998	996004	994011992
971	942841	915498611	999	998001	997002999
972	944784	918330048	1000	1000000	1000000000

DIAMETERS, CIRCUMFERENCES AND AREAS OF CIRCLES.

Example.—Required the circumference of a circle, hoop, or ring, the diameter being 3 ft. 4 in. In the column of circumferences, opposite the indicated diameter, stands 10 ft. 5⅝ in., the circumference required.

Dia. in inch.	Circum. in inch.	Area in sq. inch.	Side of = sq.	Dia. in inch.	Cir. in ft. in.	Area in sq. inch.	Area in sq. ft.
1-16	.196	.0030	.0554	4 in.	1 0½	12.566	.0879
1 8	.392	.0122	.1107	4⅛	1 0⅞	13.364	.0935
3-16	.589	.0276	.1661	4¼	1 1⅜	14.186	.0993
1-4	.785	.0490	.2115	4⅜	1 1¾	15.033	.1052
5-16	.981	.0767	.2669	4½	1 2⅛	15.904	.1113
3-8	1.178	.1104	.3223	4⅝	1 2½	16.800	.1176
7-16	1.374	.1503	.3771	4¾	1 2⅞	17.720	.1240
1-2	1.570	.1963	.4331	4⅞	1 3¼	18.665	.1306
9-16	1.767	.2485	.4995	5 in.	1 3⅝	19.635	.1374
5 9	1.963	.3068	.5438	5⅛	1 4⅛	20.629	.1444
11-16	2.159	.3712	.6093	5¼	1 4½	21.647	.1515
3-4	2.356	.4417	.6646	5⅜	1 4⅞	22.690	.1588
13-16	2 552	.5185	.7200	5½	1 5¼	23.758	.1663
7-8	2.748	.6013	.7754	5⅝	1 5⅝	24.850	.1739
15-16	2.945	.6903	.8308	5¾	1 6	25.967	.1817
1 in.	3⅛	.7854	⅞	5⅞	1 6⅜	27.108	.1897
1⅛	3½	.9940	⅞ & 3-32	6 in.	1 6¾	28.274	.1979
1¼	3⅞	1.227	1 in.	6⅛	1 7¼	29.464	.2062
1⅜	4¼	1.484	1 3-16	6¼	1 7⅝	30.679	.2147
1½	4⅝	1.767	1 5-16	6⅜	1 8	31.919	.2234
1⅝	5⅛	2.074	1 7-16	6½	1 8⅜	33 183	.2322
1¾	5½	2.405	1 9-16	6⅝	1 8¾	34.471	.2412
1⅞	5⅞	2.761	1 11-16	6¾	1 9⅛	35.784	.2504
2 in.	6¼	3.141	1¾	6⅞	1 9½	37.122	.2598
2⅛	6⅝	3.546	1⅞	7 in.	1 10	38.484	.2693
2¼	7	3.976	2 in.	7⅛	1 10⅜	39.871	.2791
2⅜	7⅜	4.430	2⅛	7¼	1 10¾	41.282	.2889
2½	7¾	4.908	2 3-16	7⅜	1 11⅛	42.718	.2990
2⅝	8¼	5.412	2 5-16	7½	1 11½	44.178	.3092
2¾	8⅝	5.939	2 7-16	7⅝	1 11⅞	45.663	.3196
2⅞	9	6.491	2 9-16	7¾	2 0⅜	47.173	.3299
3 in.	9⅜	7.068	2⅝	7⅞	2 0¾	48.707	.3409
3⅛	9¾	7.669	2¾	8 in.	2 1⅛	50.265	.3518
3¼	10¼	8.295	2⅞	8⅛	2 1½	51.848	.3629
3⅜	10⅝	8.946	3 in.	8¼	2 1⅞	53.456	.3741
3½	11	9.621	3⅛	8⅜	2 2¼	55.088	.3856
3⅝	11⅜	10.320	3¼	8½	2 2⅝	56.745	.3972
3¾	11¾	11.044	3⅜	8⅝	2 3	58.426	.4089
3⅞	12¼	11.793	3 7-16	8¾	2 3⅜	60.132	.4209

DIAMETERS, CIRCUMFERENCES, ETC., (*Continued*).

Dia. in ft. in.	Cir. in ft. in.	Area in sq. inch.	Area in sq. ft.	Dia. in ft. in.	Cir. in ft. in.	Area in sq. inch.	Area in sq. ft.
8⅞	2 3⅞	61.862	.4330	1 2⅜	3 9⅛	162.295	1.1360
9	2 4¼	63.617	.4453	1 2½	3 9½	165.130	1.1569
9⅛	2 4⅝	65.396	.4577	1 2⅝	3 9⅞	167.989	1.1749
9¼	2 5	67.200	.4704	1 2¾	3 10¼	170.873	1.1961
9⅜	2 5⅜	69.029	.4832	1 2⅞	3 10⅝	173.782	1.2164
9½	2 5¾	70.882	.4961	1 3	3 11⅛	176.715	1.2370
9⅝	2 6¼	72.759	.5093	1 3⅛	3 11½	179.672	1.2577
9¾	2 6⅝	74.662	.5226	1 3¼	3 11⅞	182.654	1.2785
9⅞	2 7	76.588	.5361	1 3⅜	4 0¼	185.661	1.2996
10	2 7⅜	78.540	.5497	1 3½	4 0⅝	188.692	1.3208
10⅛	2 7¾	80.515	.5636	1 3⅝	4 1	191.748	1.3422
10¼	2 8⅛	82.516	.5776	1 3¾	4 1⅜	194.828	1.3637
10⅜	2 8½	84.540	.5917	1 3⅞	4 1⅞	197.933	1.3855
10½	2 8⅞	86.590	.6061	1 4	4 2¼	201.062	1.4074
10⅝	2 9⅜	88.664	.6206	1 4⅛	4 2⅝	204.216	1.4295
10¾	2 9¾	90.762	.6353	1 4¼	4 3	207.394	1.4517
10⅞	2 10⅛	92.855	.6499	1 4⅜	4 3⅜	210.597	1.4741
11	2 10½	95.033	.6652	1 4½	4 3¾	213.825	1.4967
11⅛	2 10⅞	97.205	.6874	1 4⅝	4 4¼	217.077	1.5195
11¼	2 11¼	99.402	.6958	1 4¾	4 4½	220.303	1.5424
11⅜	2 11¾	101.623	.7143	1 4⅞	4 5	223.654	1.5655
11½	3 0⅛	103.869	.7290	1 5	4 5⅜	226.980	1.5888
11⅝	3 0½	106.139	.7429	1 5⅛	4 5¾	230.330	1.6123
11¾	3 0⅞	108.434	.7590	1 5¼	4 6⅛	233.705	1.6359
11⅞	3 1¼	110.753	.7752	1 5⅜	4 6½	237.104	1.6597
1	3 1⅝	113.097	.7916	1 5½	4 6⅞	240.528	1.6836
1 ⅛	3 2	115.466	.8082	1 5⅝	4 7⅜	243.977	1.7078
1 ¼	3 2½	117.859	.8250	1 5¾	4 7¾	247.450	1.7321
1 ⅜	3 2⅞	120.276	8419	1 5⅞	4 8⅛	250.947	1.7566
1 ½	3 3¼	122.718	.8590	1 6	4 8½	254.469	1.7812
1 ⅝	3 3⅝	125 185	.8762	1 6⅛	4 8⅞	258.016	1.8061
1 ¾	3 4	127.676	.8937	1 6¼	4 9¼	261.587	1.8311
1 ⅞	3 4⅜	130 192	.9113	1 6⅜	4 9⅝	265 182	1.8562
1 1	3 4¾	132.732	.9291	1 6½	4 10⅛	268.803	1.8816
1 1⅛	3 5¼	135.297	.9470	1 6⅝	4 10½	272.447	1.9071
1 1¼	3 5⅝	137.886	.9642	1 6¾	4 10⅞	276.117	1.9328
1 1⅜	3 6	140.500	.9835	1 6⅞	4 11¼	279.811	1.9586
1 1½	3 6⅜	143.139	1 0019	1 7	4 11⅝	283.529	1.9847
1 1⅝	3 6¾	145.802	1.0206	1 7⅛	5 0	287.272	1.9941
1 1¾	3 7⅛	148.489	1.0294	1 7¼	5 0½	291.039	2.0371
1 1⅞	3 7½	151.201	1.0584	1 7⅜	5 0⅞	294.831	2.0637
1 2	3 7⅞	153.938	1.0775	1 7½	5 1¼	298 648	2.0904
1 2⅛	3 8⅜	156.699	1.0968	1 7⅝	5 1⅝	302.489	2.1172
1 2¼	3 8¾	159.485	1.1193	1 7¾	5 2	306.355	2.1443

DIAMETERS, CIRCUMFERENCES, ETC., (*Continued*).

Dia. in ft. in.	Cir. in ft. in.	Area in sq. inch.	Area in sq. ft.	Dia. in ft. in.	Cir. in ft. in.	Area in sq. inch.	Area in sq. ft.
1 7⅞	5 2⅜	310.245	2.1716	2 2¾	7 0	562.002	3.9642
1 8	5 2⅞	314.160	2.1990	2 3	7 0¾	572.556	3.9761
1 8⅛	5 3¼	318.099	2.2265	2 3¼	7 1⅝	583.208	4.0500
1 8¼	5 3⅝	322.063	2.2543	2 3½	7 2⅜	593.958	4.1241
1 8⅜	5 4	326.051	2.2922	2 3¾	7 3⅛	604.807	4.2000
1 8½	5 4⅜	330.064	2.3103	2 4	7 3⅞	615.753	4.2760
1 8⅝	5 4¾	334.101	2.3386	2 4¼	7 4¾	626.798	4.3521
1 8¾	5 5⅛	338.163	2.3670	2 4½	7 5½	637.941	4.4302
1 8⅞	5 5½	342.250	2.3956	2 4¾	7 6¼	649.182	4.5083
1 9	5 5⅞	346.361	2.4244	2 5	7 7	660.521	4.5861
1 9⅛	5 6⅜	350.497	2.4533	2 5¼	7 7⅛	671.958	4.6665
1 9¼	5 6¾	354.657	2.4824	2 5½	7 8⅝	683.494	4.7467
1 9⅜	5 7⅛	358.841	2.5117	2 5¾	7 9½	695.128	4.8274
1 9½	5 7½	363.051	2.5412	2 6	7 10¼	706.860	4.9081
1 9⅝	5 7⅞	367.284	2.5708	2 6¼	7 11	718.690	4.9901
1 9¾	5 8¼	371.543	2.6007	2 6½	7 11¾	730.618	5.0731
1 9⅞	5 8¾	375.826	2.6306	2 6¾	8 0⅝	742.644	5.1573
1 10	5 9⅛	380.133	2.6608	2 7	8 1⅜	754.769	5.2278
1 10⅛	5 9½	384.465	2.6691	2 7¼	8 2⅛	766.992	5.3264
1 10¼	5 9⅞	388.822	2.7016	2 7½	8 2⅞	779.313	5.4112
1 10⅜	5 10¼	393.203	2.7224	2 7¾	8 3¾	791.732	5.4982
1 10½	5 10⅝	397.608	2.7632	2 8	8 4½	804.249	5.5850
1 10⅝	5 11	402.038	2.7980	2 8¼	8 5¼	816.865	5.6729
1 10¾	5 11½	406.493	2.8054	2 8½	8 6⅛	829.578	5.7601
1 10⅞	5 11⅞	410.972	2.8658	2 8¾	8 6⅞	842.390	5.8491
1 11	6 0¼	415.476	2.8903	2 9	8 7⅝	855.300	5.9398
1 11⅛	6 0⅝	420.004	2.9100	2 9¼	8 8½	868.308	6.0291
1 11¼	6 1	424.557	2.9518	2 9½	8 9¼	881.415	6.1201
1 11⅜	6 1⅜	429.135	2.9937	2 9¾	8 10	894.619	6.2129
1 11½	6 1¾	433.737	3.0129	2 10	8 10¾	907.922	6.3051
1 11⅝	6 2¼	438.363	3.0261	2 10¼	8 11½	921.323	6.3981
1 11¾	6 2⅝	443.014	3.0722	2 10½	9 0⅜	934.822	6.4911
1 11⅞	6 3	447.690	3.1081	2 10¾	9 1⅛	948.419	6.5863
2 0	6 3⅜	452.390	3.1418	2 11	9 1⅞	962.115	6.6815
2 0¼	6 4⅛	461.864	3.2075	2 11¼	9 2¾	975.908	6.7772
2 0½	6 4⅞	471.436	3.2731	2 11½	9 3½	989.800	6.8738
2 0¾	6 5¾	481.106	3.3410	2 11¾	9 4¼	1003.79	6.9701
2 1	6 6½	490.875	3.4081	3 0	9 5	1017.87	7.0688
2 1¼	6 7¼	500.741	3.4775	3 0¼	9 5⅞	1032.06	7.1671
2 1½	6 8⅛	510.706	3.5468	3 0½	9 6⅝	1046.35	7.2664
2 1¾	6 8⅞	520.769	3.6101	3 0¾	9 7½	1060.73	7.3662
2 2	6 9⅝	530.930	3.6870	3 1	9 8¼	1075.21	7.4661
2 2¼	6 10½	541.189	3.7583	3 1¼	9 9	1089.79	7.5681
2 2½	6 11¼	551.547	3.8302	3 1½	9 9⅞	1104.46	7.6691

DIAMETERS CIRCUMFERENCES, ETC., (*Continued*).

Dia in ft. in.	Cir. in ft. in.	Area in sq. inch.	Area in sq. ft.	Dia. in ft. in.	Cir. in ft. in.	Area in sq. inch.	Area in sq. ft.
3 1¾	9 10½	1119.24	7.7791	4 0¾	12 9⅛	1866.55	12.962
3 2	9 11⅜	1134.12	7.8681	4 1	12 9⅞	1885.74	13.095
3 2¼	10 0⅛	1149.09	7.9791	4 1¼	12 10⅝	1905.03	13.229
3 2½	10 0⅞	1164.16	8.0846	4 1½	12 11½	1924.42	13.364
3 2¾	10 1¾	1179.32	8.1891	4 1¾	13 0¼	1943.91	13.499
3 3	10 2½	1194.59	8.2951	4 2	13 1	1963.50	13.635
3 3¼	10 3¼	1209.95	8.4026	4 2¼	13 1⅞	1983.18	13.772
3 3½	10 4	1225.42	8.5091	4 2½	13 2⅝	2002.90	13.909
3 3¾	10 4⅞	1240.98	8.6171	4 2¾	13 3⅜	2022.84	14.047
3 4	10 5⅝	1256.64	8.7269	4 3	13 4¼	2042.82	14.186
3 4¼	10 6⅜	1272.39	8.8361	4 3¼	13 5	2062.90	14.325
3 4½	10 7¼	1288.25	8.9462	4 3½	13 5¾	2083.07	14.465
3 4¾	10 8	1304.20	9.0561	4 3¾	13 6½	2103.35	14.606
3 5	10 8¾	1320.25	9.1686	4 4	13 7¼	2123.72	14.748
3 5¼	10 9½	1336.40	9.2112	4 4¼	13 8⅛	2144.19	14.890
3 5½	10 10⅜	1352.65	9.3961	4 4½	13 8⅞	2164.75	15.033
3 5¾	10 11⅛	1369.00	9.5061	4 4¾	13 9¾	2185.42	15.176
3 6	10 11⅞	1385.44	9.6212	4 5	13 10½	2206.18	15.320
3 6¼	11 0¾	1401.98	9.7364	4 5¼	13 11¼	2227.05	15.465
3 6½	11 1½	1418.62	9.8518	4 5½	14 0	2248.01	15.611
3 6¾	11 2¼	1435.36	9.9671	4 5¾	14 0⅞	2269.06	15.757
3 7	11 3	1452.20	10.084	4 6	14 1⅝	2290.22	15.904
3 7¼	11 3⅞	1469.14	10.202	4 6¼	14 2⅜	2311.48	16.051
3 7½	11 4⅝	1486.17	10.320	4 6½	14 3¼	2332.83	16.200
3 7¾	11 5⅜	1503.30	10.439	4 6¾	14 4	2354.28	16.349
3 8	11 6¼	1530.53	10.559	4 7	14 4¾	2357.83	19.498
3 8¼	11 7	1537.86	10.679	4 7¼	14 5½	2397.48	16.649
3 8½	11 7¾	1555.28	10.800	4 7½	14 6⅜	2419.22	16.800
3 8¾	11 8½	1572.81	10.922	4 7¾	14 7⅛	2441.07	16.951
3 9	11 9¼	1590.43	11.044	4 8	14 7⅞	2463.01	17.104
3 9¼	11 10⅛	1608.15	11.167	4 8¼	14 8⅝	2485.05	17.227
3 9½	11 10⅞	1625.76	11.291	4 8½	14 9⅛	2507.19	17.411
3 9¾	11 11¾	1643.89	11.415	4 8¾	14 10¼	2529.42	17.565
3 10	12 0½	1661.90	11.534	4 9	14 11	2551.76	17.720
3 10¼	12 1¼	1608.02	11.666	4 9¼	14 11⅞	2574.19	17.876
3 10½	12 2	1698.23	11.793	4 9½	15 0⅝	2596.72	18.033
3 10¾	12 3⅞	1716.54	11.920	4 9¾	15 1⅜	2619.35	18.189
3 11	12 3⅝	1734.94	12.048	4 10	15 2¼	2642.08	18.347
3 11¼	12 4⅜	1753.45	12.176	4 10¼	15 2⅞	2664.91	18.506
3 11½	12 5¼	1772.05	12.305	4 10½	15 3¾	2687.83	18.665
3 11¾	12 6	1790.76	12.435	4 10¾	15 4½	2710.85	18.825
4 0	12 6¾	1809.56	12.566	4 11	15 5¼	2733.97	18.995
4 0¼	12 7½	1828.46	12.697	4 11¼	15 6⅛	2757.19	19.147
4 0½	12 8⅛	1847.45	12.829	4 11½	15 6⅞	2780.51	19.309

DIAMETERS, CIRCUMFERENCES, ETC., (*Continued*).

Dia. in ft. in.	Cir. in ft. in.	Area in sq. inch.	Area in sq. ft.	Dia. in ft. in.	Cir. in ft. in.	Area in sq. inch.	Area in sq. ft.
4 11¾	15 7⅝	2803.92	19.471	5 9	18 0¾	3739.28	25.964
5 0	15 8½	2827.44	19.635	5 9¼	18 1½	3766.43	26.155
5 0¼	15 9¼	2851.05	19.798	5 9½	18 2¼	3793.67	26.344
5 0½	15 10	2874.76	19.963	5 9¾	18 3⅛	3821.02	26.534
5 0¾	15 10¾	2898.56	20.128	5 10	18 3⅞	3848.46	26.725
5 1	15 11⅝	2922.47	20.294	5 10¼	18 4⅝	3875.99	26.916
5 1¼	16 0⅜	2946.47	20.461	5 10½	18 5⅜	3903.63	27.108
5 1½	16 1¼	2970.57	20.629	5 10¾	18 6¼	3931.36	27.301
5 1¾	16 1⅞	2994.77	20.797	5 11	18 7	3959.20	27.494
5 2	16 2¾	3019.07	20.965	5 11¼	18 7¾	3987.13	27.688
5 2¼	16 3½	3043.47	20.135	5 11½	18 8⅝	4015.16	27.883
5 2½	16 4¼	3067.96	20.305	5 11¾	18 9⅜	4043.28	28.078
5 2¾	16 5⅛	3092.56	21.476	6 0	18 10⅛	4071.51	28.274
5 3	16 5⅞	3117.25	21.647	6 0¼	18 10⅞	4099.83	28.471
5 3¼	16 6¼	3142.04	21.819	6 0½	18 11¾	4128.25	28.663
5 3½	16 7⅛	3166.92	21.992	6 0¾	19 0½	4156.77	28.866
5 3¾	16 8¼	3191.91	22.166	6 1	19 1¼	4185.39	29.065
5 4	16 9	3216.99	22.333	6 1¼	19 2⅛	4214.11	29.264
5 4¼	16 9¾	3242.17	22.515	6 1½	19 2⅞	4242.92	29.466
5 4½	16 10⅝	3267.46	22.621	6 1¾	19 3⅝	4271.83	29.665
5 4¾	16 11⅜	3292.83	22.866	6 2	19 4½	4300.85	29.867
5 5	17 0⅛	3318.31	23.043	6 2¼	19 5¼	4329.95	30.069
5 5¼	17 0⅞	3343.88	23.221	6 2½	19 6	4359.16	30.271
5 5½	17 1¾	3369.56	23.330	6 2¾	19 6¾	4388.47	30.475
5 5¾	17 2½	3395.33	23.578	6 3	19 7⅝	4417.87	30.679
5 6	17 3⅜	3421.20	23.758	6 3¼	19 8⅜	4447.37	30.884
5 6¼	17 4⅛	3447.16	23.938	6 3½	19 9⅛	4476.97	30.090
5 6½	17 4⅞	3473.23	24.119	6 3¾	19 9⅞	4506.67	31.296
5 6¾	17 5⅝	3499.39	24.301	6 4	19 10¾	4536.47	31.503
5 7	17 6½	3525.26	24.483	6 4¼	19 11½	4566.36	31.710
5 7¼	17 7¼	3552.01	24.666	6 4½	20 0¼	4596.35	31.919
5 7½	17 8	3578.47	24.850	6 4¾	20 1⅛	4626.44	32.144
5 7¾	17 8¾	3605.03	25.034	6 5	20 1⅞	4656.63	32.337
5 8	17 9⅝	3631.68	25.220	6 5¼	20 2⅝	4686.92	32.548
5 8¼	17 10⅜	3658.44	25.405	6 5½	20 3⅜	4717.30	32.755
5 8½	17 11⅛	3685.29	25.502	6 5¾	20 4¼	4747.79	32.970
5 8¾	17 11⅞	3712.24	25.779				

DIAM., ETC., OF CIRCLES, CONTENTS IN GALS., AREA IN FEET.

Diam.		Circ.		Area in ft.	Gallons.	Diam.		Circ.		Area in ft.	Gallons.
Ft.	In.	Ft.	In.		1 ft. in dpth.	Ft.	In.	Ft.	In.		1 ft. in dpth.
1		3	$1\frac{5}{8}$	.7854	5.8735	4	8	14	$7\frac{7}{8}$	17.1041	127.9112
1	1	3	$4\frac{5}{8}$	.9217	6.8928	4	9	14	11	17.7205	132.5209
1	2	3	8	1.0690	7.9944	4	10	15	$2\frac{1}{8}$	18.3476	137.2105
1	3	3	11	1.2271	9.1765	4	11	15	$5\frac{1}{4}$	18.9858	142.0582
1	4	4	$2\frac{1}{8}$	1.3962	10.4413	5		15	$8\frac{1}{2}$	19.6350	146.8384
1	5	4	$5\frac{3}{8}$	1.5761	11.7866	5	1	15	$11\frac{5}{8}$	20.2947	151.7718
1	6	4	$8\frac{1}{2}$	1.7671	13.2150	5	2	16	$2\frac{3}{4}$	20.9656	156.7891
1	7	4	$11\frac{5}{8}$	1.9689	14.7241	5	3	16	$5\frac{3}{4}$	21.6475	161.8886
1	8	5	$2\frac{3}{4}$	2.1816	16.3148	5	4	16	9	22.3400	167.0674
1	9	5	$5\frac{7}{8}$	2.4052	17.9870	5	5	17	$0\frac{1}{8}$	23.0437	172.3300
1	10	5	9	2.6398	19.7414	5	6	17	$3\frac{1}{4}$	23.7583	177.6740
1	11	6	$2\frac{1}{4}$	2.8852	21.4830	5	7	17	$6\frac{3}{8}$	24.4835	183.0973
2		6	$3\frac{3}{8}$	3.1416	23.4940	5	8	17	$9\frac{5}{8}$	25.2199	188.6045
2	1	6	$6\frac{1}{2}$	3.4087	25.4916	5	9	18	$0\frac{3}{4}$	25.9672	194.1930
2	2	6	$9\frac{5}{8}$	3.6869	27.5720	5	10	18	$3\frac{7}{8}$	26.7251	199.8610
2	3	7	$0\frac{3}{4}$	3.9760	29.7340	5	11	18	$7\frac{1}{8}$	27.4943	205.6133
2	4	7	$3\frac{7}{8}$	4.2760	32.6976	6	2	19	$4\frac{1}{2}$	29.0867	223.9472
2	5	7	7	4.5869	34.3027	6	3	19	$7\frac{1}{2}$	30.6796	229.4342
2	6	7	$10\frac{1}{4}$	4.9087	36.7092	6	6	20	$4\frac{1}{8}$	33.1831	248.1564
2	7	8	$1\frac{3}{8}$	5.2413	39.1964	6	9	21	$2\frac{3}{8}$	35.7847	267.6122
2	8	8	$4\frac{1}{2}$	5.5850	41.7668	7		21	$11\frac{7}{8}$	38.4846	287.8032
2	9	8	$7\frac{5}{8}$	5.9395	44.4179	7	3	22	$9\frac{1}{4}$	41.2825	308.7270
2	10	8	$10\frac{3}{4}$	6.3049	47.1505	7	6	23	$6\frac{3}{4}$	44.1787	330.3859
2	11	9	$1\frac{7}{8}$	6.6813	49.9654	7	9	24	$4\frac{1}{8}$	47.1730	352.7665
3		9	5	7.0686	52.8618	8		25	$1\frac{1}{2}$	50.2656	375.9062
3	1	9	$8\frac{1}{4}$	7.4666	55.8382	8	3	25	11	53.4562	399.7668
3	2	9	$11\frac{3}{8}$	7.8757	58.8976	8	6	26	$8\frac{3}{8}$	56.7451	424.3625
3	3	10	$2\frac{1}{2}$	8.2957	62.0386	8	9	27	$5\frac{3}{4}$	60.1321	449.2118
3	4	10	$5\frac{5}{8}$	8.7265	65.2602	9		28	$3\frac{1}{4}$	63.6174	475.7563
3	5	10	$8\frac{3}{4}$	9.1683	68.5193	9	3	29	$0\frac{5}{8}$	67.2007	502.5536
3	6	10	$11\frac{7}{8}$	9.6211	73.1504	9	6	29	$10\frac{1}{8}$	70.8823	530.0861
3	7	11	3	10.0846	75.4166	9	9	30	$7\frac{1}{4}$	74.6620	558.3522
3	8	11	$6\frac{1}{8}$	10.5591	78.9652	10		31	5	78.5400	587.3534
3	9	11	$9\frac{3}{8}$	11.0446	82.5959	10	3	32	$2\frac{3}{8}$	82.5160	617.0876
3	10	12	$5\frac{1}{2}$	11.5409	86.3074	10	6	32	$11\frac{3}{4}$	86.5903	647.5568
3	11	12	$3\frac{5}{8}$	12.0481	90.1004	10	9	33	$9\frac{1}{4}$	90.7627	678.2797
4		12	$6\frac{3}{4}$	12.5664	93.9754	11		34	$6\frac{5}{8}$	95.0334	710.6977
4	1	12	$9\frac{7}{8}$	13.0952	97.9310	11	3	35	$4\frac{1}{8}$	99.4021	743.3686
4	2	13	1	13.6353	101.9701	11	6	36	$1\frac{1}{2}$	103.8691	776.7746
4	3	13	$4\frac{1}{8}$	14.1862	103.0300	11	9	36	$10\frac{7}{8}$	108.4342	810.9143
4	4	13	$7\frac{1}{4}$	14.7479	110.2907	12		37	$8\frac{3}{8}$	113.0976	848.1890
4	5	13	$10\frac{1}{2}$	15.3206	114.5735	12	3	38	$5\frac{3}{4}$	117.8590	881.3966
4	6	14	$1\frac{5}{8}$	15.9043	118.9386	12	6	39	$3\frac{1}{4}$	122.7187	917.7395
4	7	14	$4\frac{5}{8}$	16.4986	123.3830	12	9	40	$0\frac{5}{8}$	127.6765	954.8159

DIAM., ETC., OF CIRCLES (*Continued*).

Diam.		Circ.		Area in ft.	Gallons.	Diam.		Circ.		Area in ft	Gallons.
Ft.	In.	Ft.	In.		1 ft. in dpth.	Ft.	In.	Ft.	In.		1 ft. in dpth.
13		40	10	132.7326	992.6274	16		50	3⅛	201.0624	1503.6250
13	3	41	7½	137.8867	1031.1719	16	3	51	0½	207.3946	1550.9797
13	6	42	4⅞	143.1391	1070.4514	16	6	51	10	213.8251	1599.0696
13	9	43	2¼	148.4896	1108.0645	16	9	52	7⅜	220.3537	1647.8930
14		43	11¾	153.9384	1151.2129	17		53	4⅞	226.9806	1697.4516
14	3	44	9⅛	159.4852	1192.6940	17	3	54	2⅛	233.7055	1747.7431
14	6	45	6⅝	165.1303	1234.9104	17	6	54	11⅝	240.5287	1798.7698
14	9	46	4	170.8735	1277.8615	17	9	55	9⅛	247.4500	1850.5301
15		47	1½	176.7150	1321.5454	18		56	6½	254.4696	1903.0254
15	3	47	10⅞	182.6545	1365.9634	18	3	57	4	261.5872	1956.2537
15	6	48	8¼	188.6923	1407.5165	18	6	58	1⅜	268.8031	2010.2171
15	9	49	5¾	194.8282	1457.0032	18	9	58	10¾	276.1171	2064.9140

TABLE OF BOARD MEASURE.

Explanation.—The length of the board is given in feet in the left-hand column; the width is given in inches in the upper row of figures, and the contents are given under the width and opposite the length. Thus the contents of a board 13 feet long and 7 inches wide will be found under 7 and opposite 13, and is 7 feet 7 inches.

Length in feet	6 in. wide.	7 in. wide.	8 in. wide.	9 in. wide.	10 in. wide.	11 in. wide.	12 in. wide.	13 in. wide.	14 in. wide.
1	0–6	0–7	0–8	0–9	0–10	0–11	1	1–1	1–2
2	1	1–2	1–4	1–6	1–8	1–10	2	2–2	2–4
3	1–6	1–9	2	2–3	2–6	2–9	3	3–3	3–6
4	2	2–4	2–8	3	3–4	3–8	4	4–4	4–8
5	2–6	2–11	3–4	3–9	4–2	4–7	5	5–5	5–10
6	3	3–6	4	4–6	5	5–6	6	6–6	7
7	3–6	4–1	4–8	5–3	5–10	6–5	7	7–7	8–2
8	4	4–8	5–4	6	6–8	7–4	8	8–8	9–4
9	4–6	5–3	6	6–9	7–6	8–3	9	9–9	10–6
10	5	5–10	6–8	7–6	8–4	9–2	10	10–10	11–8
11	5–6	6–5	7–4	8–3	9–2	10–1	11	11–11	12–10
12	6	7	8	9	10	11	12	13	14
13	6–6	7–7	8–8	9–9	10–10	11–11	13	14–1	15–2
14	7	8–2	9–4	10–6	11–8	12–10	14	15–2	16–4
15	7–6	8–9	10	11–3	12–6	13–9	15	16–3	17–6
16	8	9–4	10–8	12	13–4	14–8	16	17–4	18–8
17	8–6	9–11	11–4	12–9	14–2	15–7	17	18–5	19–10
18	9	10–6	12	13–6	15	16–6	18	19–6	21

TABLE OF BOARD MEASURE (*Continued*).

Length in feet.	6 in. wide.	7 in. wide.	8 in. wide.	9 in. wide.	10 in. wide.	11 in. wide.	12 in. wide.	13 in. wide.	14 in. wide.
19	9–6	11–1	12–8	14–3	15–10	17–5	19	20–7	22–2
20	10	11–8	13–4	15	16–8	18–4	20	21–8	23–4
21	10–6	12–3	14	15–9	17–6	19–3	21	22–9	24–6
22	11	12–10	14–8	16–6	18–4	20–2	22	23–10	25–8
23	11–6	13–5	15–4	17–3	19–2	21–1	23	24–11	26–10
24	12	14	16	18	20	22	24	26	28
25	12–6	14–7	16–8	18–9	20–10	22–11	25	27–1	29–2
26	13	15–2	17–4	19–6	21–8	23–10	26	28–2	30–4
27	13–6	15–9	18	20–3	22–6	24–9	27	29–3	31–6
28	14	16–4	18–8	21	23–4	25–8	28	30–4	32–8
29	14–6	16–11	19–4	21–9	24–2	26–7	29	31–5	33–10
30	15	17–6	20	22–6	25	27–6	30	32–6	35
31	15–6	18–1	20–8	23–3	25–10	28–5	31	33–7	36–2

	15 in. wide.	16 in. wide.	17 in. wide.	18 in. wide.	19 in. wide.	20 in. wide.	21 in. wide.	22 in wide.	23 in wide.
1	1–3	1–4	1–5	1–6	1–7	1–8	1–9	1–10	1–11
2	2–6	2–8	2–10	3	3–2	3–4	3–6	3–8	3–10
3	3–9	4	4–3	4–6	4–9	5	5–3	5–6	5–9
4	5	5–4	5–8	6	6–4	6–8	7	7–4	7–8
5	6–3	6–8	7–1	7–6	7–11	8–4	8–9	9–2	9–7
6	7–6	8	8–6	9	9–6	10	10–6	11	11–6
7	8–9	9–4	9–11	10–6	11–1	11–8	12–3	12–10	13–5
8	10	10–8	11–4	12	12–8	13–4	14	14–8	15–4
9	11–3	12	12–9	13–6	14–3	15	15–9	16–6	17–3
10	12–6	13–4	14–2	15	15–10	16–8	17–6	18–4	19–2
11	13–9	14–8	15–7	16–6	17–5	18–4	19–3	20–2	21–1
12	15	16	17	18	19	20	21	22	23
13	16–3	17–4	18–5	19–6	20–7	21–8	22–9	23–10	24–11
14	17–6	18–8	19–10	21	22–2	23–4	24–6	25–8	26–10
15	18–9	20	21–3	22–6	23–9	25	26–3	27–6	28–9
16	20	21–4	22–8	24	25–4	26–8	28	29–4	30–8
17	21–3	22–8	24–1	25–6	26–11	28–4	29–9	31–2	32–7
18	22–6	24	25–6	27	28–6	30	31–6	33	34–6
19	23–9	25–4	26–11	28–6	30–1	31–8	33–3	34–10	36–5
20	25	26–8	28–4	30	31–8	33–4	35	36–8	38–4
21	26–3	28	29–9	31–6	33–3	35	36–9	38–6	40–3
22	27–6	29–4	31–2	33	34–10	36–8	38–6	40–4	42–2
23	28–9	30–8	32–7	34–6	36–5	38–4	40–3	42–2	44–1
24	30	32	34	36	38	40	42	44	46

TABLE OF BOARD MEASURE. (*Continued*).

Length in feet.	15 in. wide.	16 in. wide.	17 in. wide.	18 in. wide.	19 in. wide.	20 in. wide.	21 in. wide.	22 in. wide.	23 in. wide.
25	31–3	33–4	35–5	37–6	39–7	41–8	43–9	45–10	47–11
26	32–6	34–8	36–10	39	41–2	43–4	45–6	47–8	49–10
27	33–9	36	38–3	40–6	42–9	45	47–3	49–6	51–9
28	35	37–4	39–8	42	44–4	46–8	49	51–4	53–8
29	36–3	38–8	41–1	43–6	45–11	48–4	50–9	53–2	55–7
30	37–6	40	42–6	45	47–6	50	52–6	55	57–6
31	38–9	41–4	43–11	46–6	49–1	51–8	54–3	56–10	59–5

Length in feet.	24 in. wide.	25 in. wide.	26 in. wide.	27 in. wide.	28 in. wide.	29 in. wide.	30 in. wide.
1	2	2–1	2–2	2–3	2–4	2–5	2–6
2	4	4–2	4–4	4–6	4–8	4–10	5
3	6	6–3	6–6	6–9	7	7–3	7–6
4	8	8–4	8–8	9	9–4	9–8	10
5	10	10–5	10–10	11–3	11–8	12–1	12–6
6	12	12–6	13	13–6	14	14–6	15
7	14	14–7	15–2	15–9	16–4	16–11	17–6
8	16	16–8	17–4	18	18–8	19–4	20
9	18	18–9	19–6	20–3	21	21–9	22–6
10	20	20–10	21–8	22–6	23–4	24–2	25
11	22	22–11	23–10	24–9	25–8	26–7	27–6
12	24	25	26	27	28	29	30
13	26	27–1	28–2	29–3	30–4	31–5	32–6
14	28	29–2	30–4	31–6	32–8	33–10	35
15	30	31–3	32–6	33–9	35	36–3	37–6
16	32	33–4	34–8	36	37–4	38–8	40
17	34	35–5	36–10	38–3	39–8	41–1	42–6
18	36	37–6	39	40–6	42	43–6	45
19	38	39–7	41–2	42–9	44–4	45–11	47–6
20	40	41–8	43–4	45	46–8	48–4	50
21	42	43–9	45–6	47–3	49	50–9	52–6
22	44	45–10	47–8	49–6	51–4	53–2	55
23	46	47–11	49–10	51–9	53–8	55–7	57–6
24	48	50	52	54	56	58	60
25	50	52–1	54–2	56–3	58–4	60–5	62–6
26	52	54–2	56–4	58–6	60–8	62–10	65
27	54	56–3	58–6	60–9	63	65–3	67–6
28	56	58–4	60–8	63	65–4	67–8	70
29	58	60–5	62–10	65–3	67–8	70–1	72–6
30	60	62–6	65	67–6	70	72–6	75
31	62	64–7	67–2	69–9	72–4	74–11	77–6

SCANTLINGS REDUCED TO BOARD MEASURE.

Explanation of Table.—At the left hand of the page will be found the length of each scantling in feet. At the head of each of the remaining columns will be found the sizes; being the width and thickness in inches, and opposite the given length of each will be found the contents of each scantling.

Feet long.	1 x 2 in.	2 x 2 in.	2 x 3 in.	2 x 4 in.	2 x 5 in.	2 x 6. in.	2 x 7 in.	2 x 8 in.
	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P	Feet. P.	Feet. P.
2	0.6	0.8	1.0	1.4	1.8	2.0	2.4	2.8
3	0.9	1.0	1.6	2.0	2.6	3.0	3.6	4.0
4	1.0	1.4	2.0	2.8	3.4	4.0	4.8	5.4
5	1.3	1.8	2.6	3.4	4.2	5.0	5.10	6.8
6	1.6	2.0	3.0	4.0	5.0	6.0	7.0	8.0
7	1.9	2.4	3.6	4.8	5.10	7.0	8.2	9.4
8	2.0	2.8	4.0	5.4	6.8	8.0	9.4	10.8
9	2.3	3.0	4.6	6.0	7.6	9.0	10.6	12.0
10	2.6	3.4	5.0	6.8	8.4	10.0	11.8	13.4
11	2.9	3.8	5.6	7.4	9.2	11.0	12.10	14.8
12	3.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0
13	3.3	4.4	6.6	8.8	10.10	13.0	15.2	17.4
14	3.6	4.8	7.0	9.4	11.8	14.0	16.4	18.8
15	3.9	5.0	7.6	10.0	12.6	15.0	17.6	20.0
16	4.0	5.4	8.0	10.8	13.4	16.0	18.8	21.4
17	4.3	5.8	8.6	11.4	14.2	17.0	19.10	22.8
18	4.6	6.0	9.0	12.0	15.0	18.0	21.0	24.0
19	4.9	6.4	9.6	12.8	15.10	19.0	22.2	25.4
20	5.0	6.8	10.0	13.4	16.8	20.0	23.4	26.8
21	5.3	7.0	10.6	14.0	17.6	21.0	24.6	28.0
22	5.6	7.4	11.0	14.8	18.4	22.0	25.8	29.4
23	5.9	7.8	11.6	15.4	19.2	23.0	26.10	30.8
24	6.0	8.0	12.0	16.0	20.0	24.0	28.0	32.0
25	6.3	8.4	12.6	16.8	20.10	25.0	29.2	33.4
26	6.6	8.8	13.0	17.4	21.8	26.0	30.4	34.8
27	6.9	9.0	13.6	18.0	22.6	27.0	31.6	36.0
28	7.0	9.4	14.0	18.8	23.4	28.0	32.8	37.4
29	7.3	9.8	14.6	19.4	24.2	29.0	33.10	38.8
30	7.6	10.0	15.0	20.0	25.0	30.0	35.0	40.0
31	7.9	10.4	15.6	20.8	25.10	31.0	36.2	41.4
32	8.0	10.8	16.0	21.4	26.8	32.0	37.4	42.8

SCANTLINGS REDUCED, ETC. (*Continued*).

Feet long.	2 x 9 in.	2 x 10 in.	2 x 11 in.	2½ x 5 in.	2½ x 6 in.	2½ x 7 in.	2½ x 8 in.	2½ x 9 in.
	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.
2	3.0	3.4	3.8	2.1	2.6	2.11	3.4	3.9
3	4.6	5.0	5.6	3.2	3.9	4.5	5.0	5.8
4	6.0	6.8	7.4	4.2	5.0	5.10	6.8	7.6
5	7.6	8.4	9.2	5.3	6.3	7.4	8.4	9.5
6	9.0	10.0	11.0	6.3	7.6	8.9	10.0	11.3
7	10.6	11.8	12.10	7.4	8.9	10.3	11.8	13.2
8	12.0	13.4	14.8	8.4	10.0	11.8	13.4	15.0
9	13.6	15.0	16.6	9.5	11.3	13.2	15.0	16.11
10	15.0	16.8	18.4	10.5	12.6	14.7	16.8	18.9
11	16.6	18.4	20.2	11.6	13.9	16.1	18.4	20.8
12	18.0	20.0	22.0	12.6	15.0	17.6	20.0	22.6
13	15.6	21.8	23.10	13.7	16.3	19.0	21.8	24.5
14	21.0	23.4	25.8	14.7	17.6	20.5	23.4	26.3
15	22.6	25.0	27.6	15.8	18.9	21.11	25.0	28.2
16	24.0	26.8	29.4	16.8	20.0	23.4	26.8	30.0
17	25.6	28.4	31.2	17.9	21.3	24.10	28.4	31.11
18	27.0	30.0	33.0	18.9	22.6	26.3	30.0	33.9
19	28.6	31.8	34.10	19.10	23.9	27.9	31.8	35.8
20	30.0	33.4	36.8	20.10	25.0	29.2	33.4	37.6
21	31.6	35.0	38.6	21.11	26.3	30.8	35.0	39.5
22	33.0	36.8	40.4	22.11	27.6	32.1	36.8	41.3
23	34.6	38.4	42.2	24.0	28.9	33.7	38.4	43.2
24	36.0	40.0	44.0	25.0	30.0	35.0	40.0	45.0
25	37.6	41.8	45.10	26.1	31.3	36.6	41.8	46.11
26	39.0	43.4	47.8	27.1	32.6	37.11	43.4	48.9
27	40.6	45.0	49.6	28.2	33.9	39.5	45.0	50.8
28	42.0	46.8	51.4	29.2	35.0	40.10	46.8	52.6
29	43.6	48.4	53.2	30.3	36.3	42.4	48.4	54.5
30	45.0	50.0	55.0	31.3	37.6	43.9	50.0	56.3
31	46.6	51.8	56.10	32.4	38.9	45.2	51.8	58.2
32	48.0	53.4	58.8	33 4	41.0	46.7	53.4	60.1

Feet long.	2½ x 10 in.	2½ x 11 in.	2½ x 12 in.	3 x 3 in.	3 x 4 in.	3 x 5 in.	3 x 6 in.	3 x 7 in.
	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.
2	4.2	4.7	5.0	1.6	2.0	2.6	3.0	3.6
3	6.3	6.11	7.6	2.3	3.0	3.9	4.6	5.3
4	8.4	9.2	10.0	3.0	4.0	5.0	6.0	7.0
5	10.5	11.6	12.6	3.9	5.0	6.3	7.6	8.9
6	12.6	13.9	15.0	4.6	6.0	7.6	9.0	10.6
7	14.7	16.1	17.6	5.3	7.0	8.9	10.6	12.3

SCANTLINGS REDUCED, ETC. (*Continued*).

Feet long.	2½ x 10 in.	2½ x 11 in.	2½ x 12 in.	3 x 3 in.	3 x 4 in.	3 x 5 in.	3 x 6 in.	3 x 7 in.
	Feet. P.	Feet. P.	Feet. P.	Feet P	Feet. P.	Feet. P.	Feet. P.	Feet. P.
8	16.8	18.4	20.0	6.0	8.0	10.0	12.0	14.0
9	18.9	20.8	22.6	6.9	9.0	11.3	13.6	15.9
10	20.10	22.11	25.0	7.6	10.0	12.6	15.0	17.6
11	22.11	25.3	27.6	8.3	11.0	13.9	16.6	19.3
12	25.0	27.6	30.0	9.0	12.0	15.0	18.0	21.0
13	27.1	29.10	32.6	9.9	13.0	16.3	19.6	22.9
14	29.2	32.1	35.0	10.6	14.0	17.6	21.0	24.6
15	31.3	34.4	37.6	11.3	15.0	18.9	22.6	26.3
16	33.4	36.8	40.0	12.0	16.0	20.0	24.0	28.0
17	35.5	39.0	42.6	12.9	17.0	21.3	25.6	29.9
18	37.6	41.3	45.0	13.6	18.0	22.6	27.0	31.6
19	39.7	43.7	47.6	14.3	19.0	23.9	28.6	33.3
20	41.8	45.10	50.0	15.0	20.0	25.0	30.0	35.0
21	43.9	48.2	52.6	15.9	21.0	26.3	31.6	36.9
22	45.10	50.5	55.0	16.6	22.0	27.6	33.0	38.6
23	47.11	52.9	57.6	17.3	23.0	28.9	34.6	40.3
24	50.0	55.0	60.0	18.0	24.0	30.0	36.0	42.0
25	52.1	57.4	62.6	18.9	25.0	31.3	37.6	43.9
26	54.2	59.7	65.0	19.6	26.0	32.6	39.0	45.6
27	56.3	61.11	67.6	20.3	27.0	33.9	40.6	47.3
28	58.4	64.2	70.0	21.0	28.0	35.0	42.0	49.0
29	60.5	66.6	72.6	21.9	29.0	36.3	43.6	50.9
30	62.6	68.9	75.0	22.6	30.0	37.6	45.0	52.6
31	64.7	71.1	77.6	23.3	31.0	38.9	46.6	54.3
32	66.8	73.5	80.0	24.0	32.0	40.0	48.0	56.0

	3 x 8 in.	3 x 9 in.	3 x 10 in.	3 x 11 in.	3 x 12 in.	4 x 4 in.	4 x 7 in.	4 x 6 in.
	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.
2	4.0	4.6	5.0	5.6	6.0	2.8	3.4	4.0
3	6.0	6.9	7.6	8.3	9.0	4.0	5.0	6.0
4	8.0	9.0	10.0	11.0	12.0	5.4	6.8	8.0
5	10.0	11.3	12.6	13.9	15.0	6.8	8.4	10.0
6	12.0	13.6	15.0	16.6	18.0	8.0	10.0	12.0
7	14.0	15.9	17.6	19.3	21.0	9.4	11.8	14.0
8	16.0	18.0	20.0	22.0	24.0	10.8	13.4	16.0
9	18.0	20.3	22.6	24.9	27.0	12.0	15.0	18.0
10	20.0	22.6	25.0	27.6	30.0	13.4	16.8	20.0
11	22.0	24.9	27.6	30.3	33.0	14.8	18.4	22.0
12	24.0	27.0	30.0	33.0	36.0	16.0	20.0	24.0
13	26.0	29.3	32.6	35.9	39.0	17.4	21.8	26.0

SCANTLINGS REDUCED, ETC. (*Continued*).

Feet long.	3 x 8 in.	3 x 9 in.	3 x 10 in.	3 x 11 in.	3 x 12 in.	4 x 4 in.	4 x 5 in.	4 x 6 in.
	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.
14	28.0	31.6	35.0	38.6	42.0	18.8	23.4	28.0
15	30.0	33.9	37.6	41.3	45.0	20.0	25.0	30.0
16	32.0	36.0	40.0	44.0	48.0	21.4	26.8	32.0
17	34.0	38.3	42.6	46.9	51.0	22.8	28.4	34.0
18	36.0	40.6	45.0	49.6	54.0	24.0	30.0	36.0
19	38.0	42.9	47.6	52.3	57.0	25.4	31.8	38.0
20	40.0	45.0	50.0	55.0	60.0	26.8	33.4	40.0
21	42.0	47.3	52.6	57.9	63.0	28.0	35.0	42.0
22	44.0	49.6	55.0	60.6	66.0	29.4	36.8	44.0
23	46.0	51.9	57.6	63.3	69.0	30.8	38.4	46.0
24	48.0	54.0	60.0	66.0	72.0	32.0	40.0	48.0
25	50.0	56.3	62.6	68.9	75.0	33.4	41.8	50.0
26	52.0	58.6	65.0	71.6	78.0	34.8	43.4	52.0
27	54.0	60.9	67.6	74.3	81.0	36.0	45.0	54.0
28	56.0	63.0	70.0	77.0	84.0	37.4	46.8	56.0
29	58.0	65.3	72.6	79.9	87.0	38.8	48.4	58.0
30	60.0	67.6	75.0	82.6	90.0	40.0	50.0	60.0
31	62.0	69.9	77.6	85.3	93.0	41.4	51.8	62.0
32	64.0	72.0	80.0	88.0	96.0	42.8	53.4	64.0
	4 x 7 in.	4 x 8 in.	4 x 9 in.	4 x 10 in.	4 x 11 in.	4 x 12 in.	5 x 5 in.	4 x 6 in.
	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.
2	4.8	5.4	6.0	6.8	7.4	8.0	4.2	5.0
3	7.0	8.0	9.0	10.0	11.0	12.0	6.3	7.6
4	9.4	10.8	12.0	13.4	14.8	16.0	8.4	10.0
5	11.8	13.4	15.0	16.8	18.4	20.0	10.5	12.6
6	14.0	16.0	18.0	20.0	22.0	24.0	12.6	15.0
7	16.4	18.8	21.0	23.4	25.8	28.0	14.7	17.6
8	18.8	21.4	24.0	26.8	29.4	32.0	16.8	20.0
9	21.0	24.0	27.0	30.0	33.0	36.0	18.9	22.6
10	23.4	26.8	30.0	33.4	36.8	40.0	20.10	25.0
11	25.8	29.4	33.0	36.8	40.4	44.0	22.11	27.6
12	28.0	32.0	36.0	40.0	44.0	48.0	25.00	30.0
13	30.4	34.8	39.0	43.4	47.8	52.0	27.1	32.6
14	32.8	37.4	42.0	46.8	51.4	56.0	29.2	35.0
15	35.0	40.0	45.0	50.0	55.0	60.0	31.3	37.6
16	37.4	42.8	47.0	53.4	58.8	64.0	33.4	40.0
17	39.8	45.4	51.0	56.8	62.4	68.0	35.5	42.6
18	42.0	48.0	54.0	60.0	66.0	72.0	37.6	45 0
19	44.4	50.8	57.0	63 4	69.8	76 0	39.7	47.6

SCANTLINGS REDUCED, ETC. (*Continued*).

Feet long.	4 x 7 in.	4 x 8 in.	4 x 9 in.	4 x 10 in.	4 x 11 in.	4 x 12 in.	5 x 5 in.	5 x 6 in.
	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.
20	46.8	53.4	60.0	66.8	73.4	80.0	41.8	50.0
21	49.0	56.0	63.0	70.0	77.0	84.0	43.9	52.6
22	51.4	58.8	66.0	73.4	80.8	88.0	45.10	55.0
23	53.8	61.4	69.0	76.8	84.4	92.0	47.11	57.6
24	56.0	64.0	72.0	80.0	88.0	96.0	50 0	60.0
25	58.4	66.8	75.0	83.4	91.8	100.0	52 1	62.6
26	60.8	69.4	78.0	86.8	95.4	104.0	54.2	65.0
27	63.0	72.0	81.0	90.0	99.0	108.0	56.3	67.6
28	65.4	74.8	84.0	93.4	102.8	112.0	58.4	70.0
29	67.8	77.4	87.0	96.8	106.4	116.0	60.5	72.6
30	70.0	80.0	90.0	100.0	110.0	120.0	62.6	75.0
31	72.4	82.8	93.0	103.4	113.8	124.0	64.7	77.6
32	74.8	85.4	96.0	106.8	116.4	128.0	66.8	80.0

Feet long.	5 x 7 in.	5 x 8 in.	5 x 9 in.	5 x 10 in.	6 x 6 in.	6 x 7 in.	6 x 8 in.	7 x 7 in.
	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.	Feet. P.
2	5.10	6.8	7.6	8.4	6.0	7.0	8.0	8.2
3	8.9	10.0	11.3	12.6	9.0	10.6	12.0	12.3
4	11.8	13.4	15.0	16.8	12.0	14.0	16.0	16.4
5	14.7	16.8	18.9	20.10	15.0	17.6	20.0	20.5
6	17.6	20.0	22.6	25.0	18.0	21.0	24.0	24.6
7	20.5	23.4	26.3	29.2	21.0	24.6	28.0	28.7
8	23.4	26.8	30.0	33.4	24.0	28.0	32.0	32.8
9	26.3	30.0	33.9	37.6	27.0	31.6	36.0	36.9
10	29.2	33.4	37.6	41.8	30.0	35.0	40.0	40.10
11	32.1	36.8	41.3	45.10	33.0	38.6	44.0	44.11
12	35.0	40.0	45.0	50.0	36.0	42.0	48.0	49.0
13	37.11	43.4	48.9	54.2	39.0	45.6	52.0	53.1
14	40.10	46.8	52.6	58.4	42.0	49.0	56.0	57.2
15	43.9	50.0	56.3	62.6	45.0	52.6	60.0	61.3
16	46.8	53.4	60.0	66.8	48.0	56.0	64.0	65.4
17	49.7	56.8	63.9	70.10	51.0	59.6	68.0	69.5
18	52.6	60.0	67.6	75.0	54.0	63.0	72.0	73.6
19	55.5	63.4	71.3	79.2	57.0	66.6	76.0	77.7
20	58.4	66.8	75.0	83.4	60.0	70.0	80.0	81.8
21	61.3	70.0	78.9	87.6	63.0	73.6	84.0	85.9
22	64.2	73.4	82.6	91.8	66.0	77.0	88.0	89.10
23	67.1	76.8	86.3	95.10	69.0	80.6	92.0	93.11
24	70.0	80.0	90.0	100.0	72.0	84.0	96.0	98.0
25	72.11	83.4	93.9	104.2	75.0	87.6	100.0	102.1

SCANTLINGS REDUCED, ETC. (*Continued*).

Feet long.	5 x 7 in. Feet. P.	5 x 8 in. Feet. P.	5 x 9 in. Feet. P.	5 x 10 in. Feet. P.	6 x 6 in. Feet. P.	6 x 7 in. Feet. P	6 x 8 in. Feet. P.	7 x 7 in. Feet. P.
26	75.10	86.8	97.6	108.4	78.0	91.0	104.0	106.2
27	78.9	90.0	101.3	112.6	81.0	94.6	108.0	110.3
28	81.8	93.4	105.0	116.8	84.0	98.0	112.0	114.4
29	84.7	96.8	108.9	120.10	87.0	101.6	116.0	118.5
30	87.6	100.0	112.6	125.0	90.0	105.0	120.0	122.6
31	90.5	103.4	116.3	129.2	93.0	108.6	124.0	126.7
32	93.4	106.8	120.0	133.4	96.0	112.0	128.0	130.8

Feet long.	7 x 8 in. Feet. P.	7 x 9 in. Feet. P.	8 x 8 in. Feet. P.	8 x 9 in. Feet. P.	8 x 10 in. Feet. P.	9 x 9 in. Feet. P.	9 x 10 in. Feet. P.	9 x 11 in. Feet. P.
2	9.4	10.6	10.8	12.0	13.4	13.6	10.0	16.6
3	14.0	15.9	16.0	18.0	20.0	20.3	22.6	24.9
4	18.8	21.0	21.4	24.0	26.8	27.0	30.0	33.0
5	23.4	26.3	26.8	30.0	33.4	33.9	37.6	41.3
6	28.0	31.6	32.0	36.0	40.0	40.6	45.0	49.6
7	32.8	36.9	37 4	42.0	46.8	47.3	52.6	57.9
8	37.4	42.0	42·8	48.0	53.4	54.0	60.0	66.0
9	42.0	47.3	48.0	54.0	60.0	60.9	67.6	74.3
10	46.8	52.6	53.4	60.0	66.8	67.6	75.0	82.6
11	51.4	57.9	58.8	66.0	73.4	74.3	82.6	90.9
12	56.0	63.0	64.0	72.0	80.0	81.0	90.0	99.0
13	60.8	68.3	69.4	78.0	86.8	87.9	97.6	107.3
14	65.4	73.6	74.8	84.0	93.4	94.6	105.0	115.6
15	70.0	78.9	80.0	90.0	100.0	101.3	112.6	123.9
16	74.8	84.0	85.4	96.0	106.8	108.0	120.0	132.0
17	79.4	89.3	90.8	102.0	113.4	114.9	127.6	140.3
18	84.0	94.6	96.0	108.0	120.0	121.6	135.0	148.6
19	88.8	99.9	101.4	114.0	126.8	128.3	142.6	156.9
20	93.4	105.0	106.8	120.0	133.4	135.0	150.0	165.0
21	98.0	110.3	112.0	126.0	140.0	141.9	157.6	173.3
22	102.8	115.6	117.4	132.0	146.8	148.6	165.0	181.6
23	107.4	120.9	122.8	138.0	153.4	155.3	172.6	189.9
24	112.0	126.0	128.0	144.0	160.0	162.0	180.0	198.0
25	116.8	131.3	133.4	150.0	166.8	168.9	187.6	206.3
26	121.4	136.6	138.8	156.0	173.4	175.6	195.0	214.6
27	126.0	141.9	144.0	162.0	180.0	182.3	202.6	222.9
28	130.8	147.0	149.4	168.0	186.8	189.0	210.0	231.0
29	135.4	152.3	154.8	174.0	193.4	195.9	217.6	239.3
30	140.0	157.6	160.0	180.0	200.0	202.6	225.0	247.6
31	144.8	162.9	165.4	186.0	206.8	209.3	232.6	255.9
32	149.4	168.0	170.8	192.0	213.4	216.0	240.0	264.0

PLANK MEASURE.

Board measure is the basis of plank measure; that is, a plank *two* inches thick, and 13 feet long, and 10 inches wide, contains evidently twice as many square feet as if only *one* inch thick; therefore, in estimating the contents of any plank, we first find the contents of the surface, taken one inch thick; and then, if the plank be $1\frac{1}{4}$ inches thick, we add one quarter of the contents to *itself*, which gives the contents (in board measure) of this plank.

Contents of Planks in Board Measure. Thickness $1\frac{1}{4}$ *inches.*

Feet long.	6 in. wide. feet.	7 in. wide. feet.	8 in. wide. feet.	9 in. wide. feet.	10 in. wide. feet.	11 in. wide. feet.	12 in. wide. feet.	13 in. wide. feet.	14 in. wide. feet.	15 in. wide. feet.	16 in. wide. feet.	17 in. wide. feet.	18 in. wide. feet.	19 in. wide. feet.	20 in. wide. feet.
10	6	7	8	9	10	11	12	14	15	16	17	18	19	20	21
11	7	8	9	10	11	13	14	15	16	17	18	20	21	22	23
12	8	9	10	11	12	14	15	16	17	19	20	21	22	24	25
13	8	9	11	12	14	15	16	18	19	20	22	23	24	26	27
14	9	10	12	13	15	16	17	19	20	22	23	25	26	28	29
15	9	11	12	14	16	17	19	20	22	23	25	27	28	30	31
16	10	12	13	15	17	18	20	22	23	25	27	28	30	32	33
17	11	12	14	16	18	19	21	23	25	27	28	30	32	34	35
18	11	13	15	17	19	21	22	24	26	28	30	32	34	36	37
19	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
20	13	15	17	19	21	23	25	27	29	31	33	35	37	40	42
21	13	15	17	20	22	24	26	28	31	33	35	37	39	42	44
22	14	16	18	21	23	25	27	30	32	34	37	39	41	44	46
23	14	17	19	22	24	26	29	31	34	36	38	41	43	46	48
24	15	17	20	22	25	27	30	32	35	37	40	42	45	47	50
25	16	18	21	23	26	29	31	34	36	39	42	44	47	49	52
26	16	19	22	24	27	30	32	35	38	41	43	46	49	51	54
27	17	20	22	25	28	31	34	37	39	42	45	48	51	53	56
28	17	20	23	26	29	32	35	38	41	44	47	50	52	55	58
29	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
30	19	22	25	28	31	34	37	41	44	47	50	53	56	59	62
31	19	23	26	29	32	36	39	42	45	48	52	55	58	61	65
32	20	23	27	30	33	37	40	43	47	50	53	57	60	63	67
33	21	24	27	31	34	38	41	45	48	52	55	58	62	65	69
34	21	25	28	32	35	39	42	46	50	53	57	60	64	67	71
35	22	26	29	33	36	40	44	47	51	55	58	62	66	69	73

PLANK MEASURE (*Continued*).

Contents of Planks in Board Measure. Thickness $1\frac{1}{2}$ *inches.*

Feet long.	6 in. wide.	7 in. wide.	8 in. wide.	9 in. wide.	10 in. wide.	11 in. wide.	12 in. wide.	13 in. wide.	14 in. wide.	15 in. wide.	16 in. wide.	17 in. wide.	18 in. wide.	19 in. wide.	20 in. wide.
	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.
10	7	9	10	11	13	14	15	16	17	19	20	21	22	24	25
11	8	10	11	12	14	15	16	18	19	21	22	23	25	26	27
12	9	10	12	13	15	16	18	19	21	22	24	25	27	28	30
13	10	11	13	15	16	18	19	21	23	24	26	28	29	31	33
14	11	12	14	16	17	19	21	23	24	26	28	30	31	33	35
15	11	13	15	17	19	21	22	24	26	28	30	32	34	36	38
16	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
17	13	15	17	19	21	23	25	28	30	32	34	36	38	41	43
18	14	16	18	20	22	25	27	29	31	34	36	38	40	43	45
19	14	17	19	21	24	26	28	31	33	36	38	40	42	46	48
20	15	17	20	22	25	27	30	32	35	38	40	42	45	48	50
21	16	18	21	24	26	29	31	34	37	40	42	44	47	50	53
22	16	19	22	25	27	30	33	35	38	42	44	46	49	53	55
23	17	20	23	26	29	32	34	37	40	44	46	48	51	55	58
24	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
25	19	22	25	28	31	35	37	40	44	47	50	53	56	60	63
26	20	23	26	29	32	36	39	42	45	49	52	55	58	62	65
27	20	24	27	30	34	38	40	43	47	51	54	57	60	64	68
28	21	24	28	31	35	39	42	45	49	53	56	59	63	67	70
29	22	25	29	33	36	40	43	47	50	55	58	61	65	69	73
30	22	26	30	34	37	42	45	48	52	57	60	63	67	72	75
31	23	27	31	35	39	43	46	50	54	59	62	65	69	74	78
32	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
33	25	29	33	37	41	45	49	53	57	62	66	70	74	78	83
34	26	30	34	38	42	47	51	55	59	64	68	72	76	81	85
35	26	31	35	39	44	48	52	56	61	66	70	74	78	83	88

Contents of Planks in Board Measure. Thickness 2 *inches.*

Feet long.	6 in. wide.	7 in. wide.	8 in. wide.	9 in. wide.	10 in. wide.	11 in. wide.	12 in. wide.	13 in. wide.	14 in. wide.	15 in. wide.	16 in. wide.	17 in. wide.	18 in. wide.	19 in. wide.	20 in. wide.
	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.
10	10	11	13	15	17	18	20	22	23	25	27	28	30	32	33
11	11	13	15	17	18	20	22	24	26	27	29	31	33	35	37
12	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
13	13	15	17	20	22	24	26	28	30	33	35	37	39	41	43
14	14	16	19	21	23	26	28	30	33	35	37	40	42	44	47

PLANK MEASURE (*Continued*).

Contents of Planks in Board Measure. Thickness 2 inches.

Feet long.	6 in. wide.	7 in. wide.	8 in. wide.	9 in. wide.	10 in. wide.	11 in. wide.	12 in. wide.	13 in. wide.	14 in. wide.	15 in. wide.	16 in. wide.	17 in. wide.	18 in. wide.	19 in. wide.	20 in. wide.
	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.
15	15	18	20	23	25	28	30	33	35	38	40	43	45	48	50
16	16	19	21	24	27	29	32	35	37	40	43	45	48	51	53
17	17	20	23	26	28	31	34	37	40	43	45	48	51	54	57
18	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
19	19	22	25	29	32	35	38	41	44	48	51	54	57	60	63
20	20	23	27	30	33	37	40	43	47	50	53	57	60	63	67
21	21	25	28	32	35	39	42	46	49	53	56	60	63	67	70
22	22	26	29	33	37	40	44	48	51	55	59	62	66	70	73
23	23	27	31	35	38	42	46	50	54	58	61	65	69	73	77
24	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
25	25	29	33	38	42	46	50	54	58	63	67	71	75	79	83
26	26	30	35	39	43	48	52	56	61	65	69	74	78	82	87
27	27	32	36	41	45	50	54	59	63	68	72	77	81	86	90
28	28	33	37	42	47	51	56	61	65	70	75	79	84	89	93
29	29	34	39	44	48	53	58	63	68	73	77	82	87	92	97
30	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
31	31	36	41	47	52	57	62	67	72	78	83	88	93	98	103
32	32	37	43	48	53	59	64	69	75	80	85	91	96	101	107
33	33	39	44	50	55	61	66	72	77	83	88	94	99	105	110
34	34	40	45	51	57	62	68	74	79	85	91	96	102	108	113
35	35	41	47	53	58	64	70	76	82	88	93	99	105	111	117

Contents of Planks in Board Measure. Thickness $2\frac{1}{4}$ inches.

Feet long	6 in. wide.	7 in. wide.	8 in. wide.	9 in. wide.	10 in. wide.	11 in. wide.	12 in. wide.	13 in. wide.	14 in. wide.	15 in. wide.	16 in. wide.	17 in. wide.	18 in. wide.	19 in. wide.	20 in. wide.
	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.
10	11	13	15	17	19	21	23	24	26	28	30	32	34	36	38
11	12	14	17	19	21	23	25	27	29	31	33	35	37	39	41
12	13	16	18	20	23	25	27	29	32	34	36	38	41	43	45
13	15	17	20	22	24	27	29	32	34	37	39	41	44	46	49
14	16	18	21	23	26	29	32	34	37	39	42	45	47	50	53
15	17	20	23	25	28	31	34	37	39	42	45	48	51	53	56
16	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
17	19	22	26	28	32	35	38	41	45	48	51	54	57	61	64
18	20	24	27	30	34	37	41	44	47	51	54	57	61	64	68
19	21	25	29	32	36	39	43	46	50	53	57	61	64	68	71

PLANK MEASURE (*Continued*).

Contents of Planks in Board Measure. Thickness $2\frac{1}{4}$ inches.

Feet long.	6 in. wide.	7 in. wide.	8 in. wide.	9 in. wide.	10 in. wide.	11 in. wide.	12 in. wide.	13 in. wide.	14 in. wide.	15 in. wide.	16 in. wide.	17 in. wide.	18 in. wide.	19 in. wide.	20 in. wide.
	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.
20	22	26	30	33	38	41	45	49	53	56	60	64	68	71	75
21	23	28	32	35	39	43	47	51	55	59	63	67	71	75	79
22	25	29	33	36	41	45	50	54	58	62	66	70	74	78	83
23	26	30	35	38	43	47	52	56	60	65	69	73	78	82	86
24	27	32	36	40	45	50	54	59	63	68	72	77	81	86	90
25	28	33	38	41	47	52	56	61	66	70	75	80	84	89	94
26	29	34	39	43	49	54	59	63	68	73	78	83	88	93	98
27	30	35	41	45	51	56	61	66	71	76	81	86	91	96	101
28	31	37	42	46	53	58	63	68	74	79	84	89	95	100	105
29	33	38	44	48	54	60	65	71	76	82	87	92	98	103	109
30	34	41	45	49	56	62	68	73	79	84	90	96	101	107	113
31	35	41	47	51	58	64	70	76	81	87	93	99	105	110	116
32	36	42	48	53	60	66	72	78	84	90	96	102	108	114	120
33	37	43	50	54	62	68	74	80	87	93	99	105	111	118	124
34	38	45	51	56	64	70	77	83	89	96	102	108	115	121	128
35	39	46	53	58	66	72	79	85	92	98	105	112	118	125	131

Contents of Planks in Board Measure. Thickness $2\frac{1}{2}$ inches.

Feet long.	6 in. wide.	7 in. wide.	8 in. wide.	9 in. wide.	10 in. wide.	11 in. wide.	12 in. wide.	13 in. wide.	14 in. wide.	15 in. wide.	16 in. wide.	17 in. wide.	18 in. wide.	19 in. wide.	20 in. wide.
	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.
10	12	15	17	19	21	23	25	27	29	31	33	35	37	40	42
11	14	16	18	21	23	25	27	30	32	34	37	39	41	44	47
12	15	18	20	23	25	28	30	33	35	38	40	43	45	48	50
13	16	19	22	24	27	30	33	35	38	41	43	46	49	51	54
14	17	20	23	26	29	32	35	38	41	44	47	50	53	55	58
15	19	22	25	28	31	34	38	41	44	47	50	53	56	59	63
16	20	23	27	30	33	37	40	43	47	50	53	57	60	63	67
17	21	25	28	32	35	39	43	46	50	53	57	60	64	67	71
18	22	26	30	34	38	41	45	49	53	56	60	64	68	71	75
19	24	28	32	36	40	44	48	51	55	59	63	67	71	75	79
20	25	29	33	38	42	46	50	54	58	63	67	71	75	79	83
21	26	31	35	39	44	48	53	57	61	66	70	74	79	83	88
22	27	32	37	41	46	50	55	60	64	69	73	78	83	87	92
23	29	34	38	43	48	53	58	62	67	72	77	81	86	91	96
24	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100

PLANK MEASURE (*Continued*).

Contents of Planks in Board Measure. Thickness 2½ inches.

Feet long.	6 in. wide.	7 in. wide.	8 in. wide.	9 in. wide.	10 in. wide.	11 in. wide.	12 in. wide.	13 in. wide.	14 in. wide.	15 in. wide.	16 in. wide.	17 in. wide.	18 in. wide.	19 in. wide.	20 in. wide.
	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.
25	31	36	42	47	52	57	63	68	73	78	83	89	94	99	104
26	32	38	43	49	54	60	65	70	76	81	87	92	98	103	108
27	34	39	45	51	56	62	68	73	79	84	90	96	101	107	113
28	35	41	47	53	58	64	70	76	82	88	93	99	105	111	117
29	36	42	48	54	60	66	73	79	85	91	97	103	109	115	121
30	37	44	50	56	63	69	75	81	88	94	100	106	113	119	125
31	39	45	52	58	65	71	78	84	90	97	103	110	116	123	129
32	40	47	53	60	67	73	80	87	93	100	107	113	120	127	133
33	41	48	55	62	69	76	83	89	96	103	110	117	124	131	138
34	42	50	57	64	71	78	85	92	99	106	113	120	128	135	142
35	44	51	58	66	73	80	88	95	102	109	117	124	131	139	146

Contents of Planks in Board Measure. Thickness 3 inches.

Feet long.	6 in. wide.	7 in. wide.	8 in. wide.	9 in. wide.	10 in. wide.	11 in. wide.	12 in. wide.	13 in. wide.	14 in. wide.	15 in. wide.	16 in. wide.	17 in. wide.	18 in. wide.	19 in. wide.	20 in. wide.
	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.
10	15	17	20	22	25	27	30	32	35	37	40	42	45	47	50
11	16	19	22	25	27	30	33	36	38	41	44	47	49	52	55
12	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
13	20	23	26	29	33	36	39	42	46	49	52	55	59	62	65
14	21	25	28	32	35	39	42	46	49	53	56	60	63	67	70
15	22	26	30	34	38	41	45	49	53	56	60	64	68	71	75
16	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
17	25	30	34	38	43	47	51	55	60	64	68	72	77	81	85
18	27	32	36	41	45	50	54	59	63	68	72	77	81	86	90
19	29	33	38	43	48	52	57	62	67	71	76	81	86	90	95
20	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
21	31	37	42	47	53	58	63	68	74	79	84	89	95	100	105
22	33	39	44	50	55	61	66	72	77	83	88	94	99	105	110
23	34	40	46	52	58	63	69	75	81	86	92	98	104	109	115
24	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
25	37	44	50	56	63	69	75	81	88	94	100	106	113	119	125
26	39	46	52	59	65	72	78	85	91	98	104	111	117	124	130
27	40	47	54	61	68	74	81	88	95	101	108	115	122	128	135
28	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
29	43	51	58	65	73	80	87	94	102	109	116	123	131	138	145
30	45	53	60	68	75	83	90	98	105	113	120	128	135	143	150

PLANK MEASURE (*Continued*).

Contents of Planks in Board Measure. Thickness 3 inches.

Feet long.	6 in. wide. feet.	7 in. wide. feet.	8 in. wide. feet.	9 in. wide. feet.	10 in. wide. feet.	11 in. wide. feet.	12 in. wide. feet.	13 in. wide. feet.	14 in. wide. feet.	15 in. wide. feet.	16 in. wide. feet.	17 in. wide. feet.	18 in. wide. feet.	19 in. wide. feet.	20 in. wide. feet.
31	46	54	62	70	78	85	93	101	109	116	124	132	140	147	155
32	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
33	49	58	66	74	83	91	99	107	116	124	132	140	149	157	165
34	50	60	68	77	85	94	102	111	119	128	136	145	153	162	170
35	52	61	70	79	88	96	105	114	123	131	140	149	158	166	175

Contents of Planks in Board Measure. Thickness $3\frac{1}{2}$ inches.

Feet long.	6 in. wide. feet.	7 in. wide. feet.	8 in. wide. feet.	9 in. wide. feet.	10 in. wide. feet.	11 in. wide. feet.	12 in. wide. feet.	13 in. wide. feet.	14 in. wide. feet.	15 in. wide. feet.	16 in. wide. feet.	17 in. wide. feet.	18 in. wide. feet.	19 in. wide. feet.	20 in. wide. feet.
10	17	20	23	26	29	32	35	38	41	44	47	50	52	55	58
11	19	22	24	29	32	35	38	41	45	47	51	54	57	61	64
12	20	25	28	32	35	39	42	46	49	53	56	60	63	67	70
13	23	27	30	34	38	42	46	49	53	57	61	64	68	72	76
14	25	29	33	37	41	45	49	53	57	61	65	69	74	78	82
15	26	31	35	39	44	48	53	57	61	66	70	74	79	83	88
16	28	33	37	42	47	51	56	61	65	70	75	79	84	89	93
17	30	35	40	45	50	55	60	64	69	74	79	84	89	94	99
18	32	37	42	47	53	58	63	68	74	79	84	89	95	100	105
19	33	39	44	50	55	61	67	72	78	83	89	94	100	105	111
20	35	41	47	53	58	64	70	76	82	88	93	99	105	111	117
21	37	43	49	55	61	67	74	80	86	92	98	104	110	116	123
22	38	45	51	58	64	71	77	83	90	96	103	109	116	122	128
23	40	47	54	60	67	74	81	87	94	101	107	114	121	127	134
24	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
25	44	51	58	66	73	80	88	95	102	109	117	124	131	139	146
26	45	53	61	68	76	83	91	99	106	114	121	129	137	144	152
27	47	55	63	71	79	87	95	102	110	118	126	134	142	150	158
28	49	57	65	74	82	90	98	106	114	123	131	139	147	155	163
29	51	59	68	76	85	93	102	110	118	127	135	144	152	161	169
30	52	61	70	79	88	96	105	114	123	131	140	149	158	166	175
31	54	63	72	81	90	99	109	118	127	136	145	154	163	172	181
32	56	65	75	84	93	103	112	121	131	140	149	159	168	177	187
33	58	67	77	87	96	106	116	125	135	144	154	164	173	183	193
34	59	69	79	89	99	109	119	129	139	149	159	169	179	188	198
35	61	71	82	92	102	112	123	133	143	153	163	174	184	194	204

PLANK MEASURE (*Continued*).

Contents of Planks in Board Measure. Thickness 4 inches

Feet long.	6 in. wide.	7 in. wide.	8 in. wide.	9 in. wide.	10 in. wide.	11 in. wide.	12 in. wide.	13 in. wide.	14 in. wide.	15 in. wide.	16 in. wide.	17 in. wide.	18 in. wide.	19 in. wide.	20 in. wide.
	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.
10	20	23	27	30	33	37	40	43	47	50	53	57	60	63	67
11	22	26	29	33	37	40	44	48	51	54	59	62	66	69	73
12	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
13	26	30	35	39	43	48	52	56	61	65	69	72	78	82	87
14	28	33	37	42	47	51	56	61	65	70	75	79	84	89	93
15	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
16	32	37	43	48	53	59	64	69	75	80	85	91	96	101	107
17	34	40	45	51	57	62	68	74	79	85	91	96	102	108	113
18	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
19	38	44	51	57	63	70	76	82	89	95	101	108	114	120	127
20	40	47	53	60	67	73	80	87	93	100	107	113	120	127	133
21	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
22	44	51	59	66	73	81	88	95	103	110	117	125	132	139	147
23	46	54	61	69	77	84	92	100	107	115	123	130	138	146	153
24	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
25	50	58	67	75	83	92	100	108	117	125	133	142	150	158	167
26	52	61	69	78	87	95	104	113	121	130	139	147	156	165	173
27	54	63	72	81	90	99	108	117	126	135	144	153	162	171	180
28	56	65	75	84	93	103	112	121	131	140	149	159	168	177	187
29	58	68	77	87	97	106	116	125	135	145	155	164	174	184	193
30	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
31	62	72	83	93	103	114	124	134	145	155	165	176	186	196	207
32	64	75	85	96	107	117	128	139	149	160	171	181	192	203	213
33	66	77	88	99	110	121	132	143	154	165	176	187	198	209	220
34	68	79	91	102	113	125	136	147	159	170	181	193	204	215	227
35	70	82	93	105	117	128	140	152	163	175	187	198	210	222	233

Contents of Planks in Board Measure. Thickness 4½ inches.

Feet long.	6 in. wide.	7 in. wide.	8 in. wide.	9 in. wide.	10 in. wide.	11 in. wide.	12 in. wide.	13 in. wide.	14 in. wide.	15 in. wide.	16 in. wide.	17 in. wide.	18 in. wide.	19 in. wide.	20 in. wide.
	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.
10	22	26	30	34	37	41	45	49	52	56	60	64	67	71	75
11	25	29	33	37	41	45	49	54	58	62	66	70	74	78	82
12	27	32	36	41	45	50	54	59	63	68	72	77	81	86	90
13	29	34	39	44	49	54	59	63	68	73	78	83	88	93	98
14	31	37	42	47	53	58	63	68	74	79	84	89	95	100	105

PLANK MEASURE (*Continued*).

Contents of Planks in Board Measure. Thickness 4½ inches.

Feet long.	6 in. wide.	7 in. wide.	8 in. wide.	9 in. wide.	10 in. wide.	11 in. wide.	12 in. wide.	13 in. wide.	14 in. wide.	15 in. wide.	16 in. wide.	17 in. wide.	18 in. wide.	19 in. wide.	20 in. wide.
	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.
15	34	39	45	51	56	62	68	73	79	84	90	96	101	107	113
16	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
17	38	45	51	57	64	70	77	83	89	96	102	108	115	121	128
18	40	47	54	61	68	74	81	88	95	101	108	115	122	128	135
19	43	50	57	64	71	78	86	93	100	107	114	121	128	135	143
20	45	53	60	68	75	83	90	98	105	113	120	128	135	143	150
21	47	55	63	71	79	87	95	102	110	118	126	134	142	150	158
22	49	58	66	74	83	91	99	107	116	124	132	140	149	157	165
23	52	60	69	78	86	95	104	112	121	129	138	147	155	164	173
24	54	63	72	81	90	99	108	117	126	135	144	153	162	171	180
25	56	66	75	84	94	103	113	122	131	141	150	159	169	178	188
26	59	68	78	88	98	107	117	127	137	146	156	166	176	185	195
27	61	71	81	91	101	111	122	132	142	152	162	172	182	192	205
28	63	74	84	95	105	116	126	137	147	158	168	179	189	200	210
29	65	76	87	98	109	120	131	141	152	163	174	185	196	207	218
30	67	79	90	101	113	124	135	146	158	169	180	191	203	214	225
31	70	81	93	105	116	128	140	151	163	174	186	198	209	221	233
32	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240
33	74	87	99	111	124	136	149	161	173	186	198	210	223	235	248
34	76	89	102	115	128	140	153	166	179	191	204	217	230	242	255
35	79	92	105	118	131	144	158	171	184	197	210	223	236	249	263

WAGES TABLE.

Salaries and Wages by the Year, Month, Week or Day.

Per Year.	Per Month	Per Week.	Per Day	Per Year.	Per Month	Per Week.	Per Day
$	$ c.	$ c.	$ c.	$	$ c.	$ c.	$ c.
20 is	1.67	.38	.05	65 is	5.42	1.25	.18
25	2.08	.48	.07	70	5.83	1.34	.19
30	2.50	.58	.08	75	6.25	1.44	.21
35	2.92	.67	.10	80	6.67	1.53	.22
40	3.33	.77	.11	85	7.08	1.63	.23
45	3.75	.86	.12	90	7.50	1.73	.25
50	4.17	.96	.14	95	7.92	1.82	.26
55	4.58	1.06	.15	100	8.33	1.92	.27
60	5.00	1.15	.16	105	8.75	2.01	.29

WAGES TABLE (*Continued*).

Salaries and Wages by the Year, Month, Week or Day.

Per Year.	Per Month	Per Week.	Per Day	Per Year.	Per Month	Per Week.	Per Day
$	$ c.	$ c.	$ c.	$	$ c.	$ c.	$ c.
110 is	9.17	2.11	.30	340 is	28.33	6.52	.93
115	9.58	2.21	.32	350	29.17	6.71	.96
120	10.00	2.30	.33	360	30.00	6.90	.99
125	10.42	2.40	.34	370	30.83	7.10	1.01
130	10.83	2.49	.36	375	31.25	7.19	1.03
135	11.25	2.59	.37	380	31.67	7.29	1.04
140	11.67	2.69	.38	390	32.50	7.48	1.07
145	12.08	2.78	.40	400	33.33	7.67	1.10
150	12.50	2.88	.41	425	35.42	8.15	1.16
155	12.92	2.97	.42	450	37.50	8.63	1.23
160	13.33	3.07	.44	475	39.58	9.11	1.30
165	13.75	3.16	.45	500	41.67	9.59	1.37
170	14.17	3.26	.47	525	43.75	10.07	1.44
175	14.58	3.36	.48	550	45.83	10.55	1.51
180	15.00	3.45	.49	575	47.92	11.03	1.58
185	15.42	3.55	.51	600	50.00	11.51	1.64
190	15.83	3.64	.52	625	52.08	11.99	1.71
195	16.25	3.74	.53	650	54.17	12.47	1.78
200	16.57	3.84	.55	675	56.25	12.95	1.85
205	17.08	3.93	.56	700	58.33	13.42	1.92
210	17.50	4.03	.58	725	60.42	13.90	1.99
215	17.92	4.12	.59	750	62.50	14.38	2.05
220	18.33	4.22	.60	775	64.58	14.86	2.12
225	18.75	4.31	.62	800	66.67	15.34	2.19
230	19.17	4.41	.63	825	68.75	15.82	2.26
235	19.58	4.51	.64	850	70.83	16.30	2.33
240	20.00	4.60	.66	875	72.92	16.78	2.40
245	20.42	4.70	.67	900	75.00	17.26	2.47
250	20.83	4.79	.69	925	77.08	17.74	2.53
255	21.25	4.89	.70	950	79.17	18.22	2.60
260	21.67	4.99	.71	975	81.25	18.70	2.67
265	22.08	5.08	.73	1000	83.33	19.18	2.74
270	22.50	5.18	.74	1050	87.50	20.14	2.88
275	22.92	5.27	.75	1100	91.67	21.10	3.01
280	23.33	5.37	.77	1150	95.83	22.06	3.15
285	23.75	5.47	.78	1200	100.00	23.01	3.29
290	24.17	5.56	.79	1250	104.17	23.29	3.42
295	24.58	5.66	.81	1300	108.33	24.93	3.56
300	25.00	5.75	.82	1350	112.50	25.89	3.70
310	25.83	5.95	.85	1400	116.67	26.85	3.84
320	26.67	6.14	.88	1450	120.84	27.80	3.98
325	27.08	6.23	.89	1500	125.00	28.77	4.11
330	27.50	6.33	.90	1600	133.34	30.68	4.38

WAGES TABLE.

Calculated on a Scale of Ten Hours Labor per day. The Time, in Hours and Days, is noted in the Left-hand Column, and the Amount of Wages under the respective headings as noted below.

	Wages.	$1.00	$1.50	$2.00	$2.50	$3.00	$3.50	$4.00	$4.50	$5.00	$5.50	$6.00
Hours.	½	.1	.1 1-4	.1 2-3	2	.2 1-2	.3	.3 1-2	.2 3-4	.4 1-2	.4 1-2	.5
	1	.1 2-3	.2 1-2	.3 1-3	.4 1-6	.5	.6	.6 2-3	.7 1-2	.8 1-3	.9 1-6	.10
	2	.3 1-3	.5	.6 2-3	.8 1-3	.10	.11 2-3	.13 1-3	.15	.16 2-3	.18 1-3	.20
	3	.5	.7 1-2	.10	.12 1-2	.15	.17 1-2	.20	.22 1-2	.25	.27 1-2	.30
	4	.6 2-3	.10	.13 1-2	.16 2-3	.20	.23 1-3	.26 2-3	.30	.33 1-3	.30 2-3	.40
	5	.8 1-3	.12 1-2	.16 2-3	.21	.25	.29 1-6	.33 1-3	.37 1-2	.41 2-3	.46	.50
	6	.10	.15	.20	.25	.30	.35	.40	.45	.50	.55	.60
	7	.11 2-3	.17 1-2	.23 1-3	.29 1-2	.35	.41	.46 2-3	.52 1-2	.58 1-3	.64 1-6	.70
	8	.13 1-3	.20	.26 2-3	.33 1-3	.40	.46 2-3	.53 1-3	.60	.66 2-3	.73 1-3	.80
	9	.15	.22 1-2	.30	.37 1-2	.45	.52 1-2	.60	.67 1-2	.75	.82 1-2	.90
Days.	1	.16 2-3	.25	.33 1-3	.41 2-3	.50	.58 1-3	.66 2-3	.75	.83 1-3	.91 2-3	1.00
	2	.33 1-3	.50	.66 2-3	.83 1-3	1.00	1.16 2-3	1.33 1-3	1.50	1.66 2-3	1.83 1-3	2.00
	3	.50	.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
	4	.66 2-3	1.00	1.33 1-3	1.66 2-3	2.00	2.33 1-3	2.66 2-3	3.00	3.33 1-3	3.66 2-3	4.00
	5	.83 1-3	1.25	1.66 2-3	2.08 1-3	2.50	2.91 2-3	3.33 1-3	3.75	4.16 2-3	4.58 1-3	5.00
	6	1.00	1.50	2.00	2.50	3.00	6.50	4.00	4.50	5.00	5.50	6.00

	Wages.	$6.50	$7.00	$7.50	$8.00	$9.00	$10.00	$11.00	$12.00	$13.00	$14.00	$15.00
Hours.	½	.5 1-2	.6	.6 1-4	.6 2-3	.7 1-2	.8 1-3	.9	.10	11	12	.12 1-2
	1	.11	.11 2-3	.12 1-2	.13 1-3	.15	.16 2-3	.18 1-3	.20	.22	.23 1-2	.25
	2	.21 2-3	.23 1-3	.25	.26 2-3	.30	.33 1-3	.36 2-3	.40	.43 1-3	.46 2-3	.50
	3	.32 1-2	.35	.37 1-2	.40	.45	.50	.55	.60	.65	.70	.75
	4	.43 1-3	.46 2-3	.50	.53 1-3	.60	.66 2-3	.73 1-3	.80	.86 2-3	.93 1-3	1.00
	5	.54 1-6	.58 1-3	.62 1-2	.66 2-3	.75	.83 1-3	.91 2-3	1.00	1.08 1-3	1.16 2-3	1.25
	6	.65	.70	.75	.80	.90	1.00	1.10	1.20	1 30	1.40	1.50
	7	.76	.81 2-3	.87 1-2	.93 1-3	1.05	1.16 2-3	1.28 1-3	1.40	1.52	1.63 1-3	1.75
	8	.86 2-3	.93 1-3	1.00	1.06 2-3	1.20	1.33 1-3	1.46 2-3	1.60	1.73 1-3	1.86 2-3	2.00
	9	.97 1-2	1.05	1.12 1-2	1.20	1.35	1.50	1.65	1.80	1.95	2.10	2.25
Days.	1	1.08 1-3	1.16 2-3	1.25	1.33 1-3	1.50	1.66 2-3	1.83 1-3	2.00	2.17	2.33 1-3	2.50
	2	2.16 2-3	2.33 1-3	2.50	2.66 2-3	3.00	3.33 1-3	3.66 2-3	4.00	4.34	4.66 2-3	5.00
	3	3.25	3.50	3.75	4.00	4.50	5.00	5.50	6.00	6.51	6.99 2-3	7.50
	4	4.33 1-3	4.66 2-3	5.09	5.33 1-3	6.00	6.66 2-3	7.33 1-3	8.00	8.68	9.33	10.00
	5	5.41 2-3	5.83 1-3	6.25	6.66 2-3	7.00	8.33 1-3	9.16 2-3	10.00	10.85	11.66 1-3	12.50
	6	6.50	7.00	7.50	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00

If the desired number of days or amount of wages is not in the table, double or treble any suitable number of days or amount of money, as the case may be, until you obtain the desired number of days and the wages to correspond.

TABLE FOR COMPUTING WAGES, RENT, BOARD, ETC.

The sum will be found heading the columns, and the days and weeks on the extreme left hand c lumn. If the desired snm is not in the table, double or treble two or three suitable numbers.

Time.		$2.50	$2.75	$3.00	$3.25	$3 50	$3.75	$4.00	$4.25	$4.50	$4.75
Days.	1	.36	.39	.43	.46	.50	.53	.57	.61	.64	.63
	2	.72	.78	.86	.93	1.00	1.07	1 14	1.21	1.28	1.36
	3	1.08	1.17	1.29	1 39	1.50	1.61	1.71	1.82	1.93	2.03
	4	1.44	1.56	1.71	1.86	2.00	2.14	2.28	2.43	2.57	2.71
	5	1.80	1.95	2.14	2.32	2.50	2.68	2.86	3.03	3.21	3.39
	6	2.15	2.34	2.57	2.78	3.00	3.21	3.43	3.64	3.86	4.07
Weeks.	1	2 50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75
	2	5 00	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50
	3	7.50	8.25	9.00	9.75	10.50	11.25	12.00	12.75	13.50	14.25
	4	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19 00
	5	12.50	13.75	15 00	16 25	17. 0	18.75	20.00	21.25	22.50	23.75

Time.		$5 00	$5.25	$5.50	$5.75	$6.00	$6.25	$6.50	$6.75	$7.00	$3.00
Days.	1	.71	.75	.79	.82	.86	.89	.93	.96	1.00	1.14
	2	1.43	1.50	1.58	1.64	1.72	1.78	1.86	1.92	2.00	2.28
	3	2.14	2.25	2.37	2.46	2.28	2.67	2.79	2.88	3.00	3.52
	4	2.86	3.00	3.15	3.28	3.44	3.56	3.72	3.84	4.00	4.25
	5	3.57	3.75	3.94	4.10	4 30	4.45	4 65	4.80	5.00	5.72
	6	4.28	4.50	4.73	4.92	5.16	5.34	5 58	5.76	6.00	6.86
Weeks.	1	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00	8.00
	2	10.00	10.50	11.00	11.50	12.00	12.50	13.00	13.50	14 00	16.00
	3	15.00	15.75	16.50	17.25	18 00	18.75	19.50	20.25	21.00	24.00
	4	20.00	21.00	22.00	23.00	24 00	25.00	26.00	27.00	28.00	32.00
	5	25.00	26.25	27.50	28.75	30 00	31.25	32 50	33.50	35.00	40 00

SIZES AND CAPACITIES OF CRIBS AND BOXES.

Crib 6½ ft. long, 3¾ ft. broad, 3¼ deep, 63½ bush. ½ peck.

Box 4 ft. long, 3 ft. 5 in. wide, 2 ft. 8 in deep, 36½ c. ft., 1 ton of coal.

Stone or Box 4½ ft. long, 2½ ft wide, 2 ft. deep, 22½ cubic feet.

Box 2 ft. long, 1 foot 4 in. wide, 2 ft. 8 in deep, 10,722 cub. in. 1 barrel.

Box 2 ft. long, 1 foot 2 in. wide, 1 foot 2 in. deep, 5,376 cub. in. ½ barrel.

Box 1 foot 2 in. long by 16 8-10 in. wide and 8 in. deep, 1 bushel.

Box 12 x 11 2-10 in., 8 in. deep, 1.075 2-10 in. or ½ bushel.

Box 8 x 8 4-10 in. and 8 in. deep, 537 6-10 cub. in. or 1 peck.

Box 8 x 8 in. and 4 2-10 in. deep, 268 8-10 cub. in. or ½ peck.

Box 7 x 4 in. and 4 8-10 in. deep, 134 4-10 cub. in. ½ gallon.

Box 4 x 4 in. and 4 2-10 in deep, 67 2-10 cub. in. 1 quart.

LIEN LAWS.

The following will give an idea of the workings of the lien laws of the various states.

ALABAMA.—By act, approved March 19th, 1875, a lien is given to laborers and employees (except officers) of railroads in this State, for work and labor done by them as such. Such extends to all the property, rights, effects and credits of every description of such railroad companies. A lien is also given to all contractors, mechanics, builders, bricklayers, plasterers, painters, and every other person whatever in the State of Alabama, for work and labor done by them as such, and for materials furnished; and such lien extends to all the rights, title and interest of the person or persons for whom the work is done, or the materials furnished, in the property upon which such work is done and for which such materials are furnished, including the land upon which such property may be situated. *Provided* that all the liens given under this act shall all be held to be waived, unless proceedings are commenced within six months after the completion of such work, to enforce same. Such liens are enforced by process of attachment.

ARKANSAS.—Mechanics, material men and laborers have a lien on land and improvements to the extent of their labor. The original contractor must file his lien within three months after all the things shall have been done or furnished. Sub-contractors must give notice to owner, proprietor, agent or trustee, before or at the time he furnishes any of the things or performs services. These have precedence over all other subsequent incumbrances.

CONNECTICUT.—Material men and mechanics have a lien on land and buildings for the amount of their claim, provided the same exceeds $25. To render the lien valid, the claimant must file a certificate of the claim, verified by oath, with the town clerk within 60 days from the time when he commenced to furnish materials or render services. Where the claimant is a sub-contractor he must, unless his contract with the original contractor is in writing, assented to by the proprietor, give notice in writing to the proprietor within 60 days of the time he commences to furnish materials or render services that he intends to claim a lien, otherwise he can have none. This lien takes precedence of all subsequent incumbrances.

CALIFORNIA.—Mechanics and material men have a lien for labor and materials on the land and improvements to the extent of their claims. The original contractor must file his claim within 60 days, and the laborers within 30 days, after the debt accrued. This lien attaches from the commencement of the work, and has precedence over any subsequent or previous unrecorded encumbrance.

COLORADO.—Persons who perform work or furnish materials to the amount of more than $25 for the construction or repairing of any building, may have a lien thereon. Principal contractors must file their lien within 40, and sub-contractors within 20 days after last work done or material furnished. Action thereof must be commenced within 6 months from date of filing lien.

DISTRICT OF COLUMBIA.—Any person who, by virtue of any contract with owner of any building or his agent, performs labor or furnishes materials for construction or repair of such building, shall, upon filing in office of clerk of the Supreme Court of the District, at any time after commencement of the building, and within three months after completion of such building or repairs, a notice of his intention to hold a lien upon the property for the amount due or to become due to him, specifically setting forth the amount claimed, have a lien upon such building and lot of ground upon which the same is situated, for such labor done or materials furnished when amount exceeds $20. Any sub-contractor, journeyman or laborer employed in construction or repair of any building, or in furnishing any materials or machinery for same, may give, at any time, owner thereof notice in writing, particularly setting forth amount of his claim and services rendered for which his employer is indebted to him, and that he holds the owner responsible, and the owner of the building shall be liable for the claims but not to exceed the amount due from him to employer at time of notice, or subsequently, which may be recovered in an action.

DELAWARE.—Mechanics, builders, artisans, laborers or other persons, having performed or furnished work and labor or materials or both, to an amount exceeding $25, in or for the erection, alteration or repair of any house, building or structure, in pursuance of any contract express or implied, with the owner or agent of such building or structure, may at any time within six months from the completion of said work and labor, or the furnishing of such materials, file in the office of the prothonotary of the county in which said building is situate a bill of particulars of his claim, with an affidavit setting forth that the defendant is justly indebted to the plaintiff in a sum of $25, and has refused or neglected to pay or secured to be paid to the said plaintiff the amount due on his claim. The affidavit must identify the property and give the names of the parties claimant, and the owner or reputed owner of said building. Judgment obtained shall be a lien on said building or structure and the real estate attached thereto upon which the same is erected, and shall relate back to the day upon which the work or labor, or furnishing of materials was commenced, and shall take priority according. Where several contractors are employed, in pursuance of any contract with the owner or agent, there shall be no priority of lien, but all be paid pro rata.

FLORIDA.—Mechanics and other persons performing labor or furnishing materials for the construction or repair of any building, or who may have furnished any engine or other machinery for any

mill, distillery or manufactory, may have a lien on such building, mill or distillery, etc., for the same to the extent of the interest of the tenant or contractor. Sub-contractors, journeymen and laborers have also lien, upon their giving notice in writing to the owner that they hold him responsible for whatever may be due them.

GEORGIA.—Laborers shall have a general lien upon the property of their employers liable to levy and sale for their labor, which is superior to all other liens, except liens for taxes, the special liens of landlords on yearly crops, and such other liens as are declared by law superior to them. Laborers shall also have a special lien on the products of their labor superior to all other liens, except liens for taxes, and special liens of landlords on yearly crops, to which they shall be inferior. All mechanics of every sort, who have taken no personal security therefor, shall, for work done and material furnished in building, repairing or improving any real estate of their employers, all contractors, material men and persons furnishing material for the improvement of real estate, all contractors for building factories, furnishing material for the same, and all machinists and manufacturers of machinery including corporations engaged in such business, who may furnish or put up in any county of this State any steam mills or other machinery, or who may repair the same, and all contractors to build railroads shall each have a special lien on such real estate, factories and railroads.

INDIANA.—Material men and mechanics have lien for labor and material on the land and improvements to the extent of their claims. The original contractor must file his claim within two months, laborers within 60 days, and all other persons claiming a lien within two months after the debt accrued. This lien has precedence over all other liens or encumbrances placed on the property subsequent to the commencement of the building or improvements. Must be foreclosed in 12 months.

IOWA.—Every mechanic or other person doing any labor, or furnishing any material, machinery or fixtures for the erection or improvement of any building, by virtue of any contract with the owner, agent, trustee, contractor or sub-contractor, shall have a mechanics' lien on the buildings, fixtures and real estate. Railways are liable in the same way as other property for construction and improvements. No person who takes collateral security on the same contract is entitled to a lien. The lien must be filed in ninety days after the labor to affect purchases or encumbrances without notice; as between the original parties, it can be filed any time in five years.

ILLINOIS.—Any person, by contract, express or implied, or both, with the owner of any lot or piece of ground, furnishing labor or materials in building, altering, repairing or ornamenting any house or building on such lot has a lien upon such lot or building for the amount due him for such labor or material. To the extent that the furnishing such labor or materials has increased the value

of such property, such lien takes precedence over prior encumbrances. Proceedings to enforce a mechanics' lien must be commenced by the original contractor within six months from the time when the last payment for labor, or materials becomes due, in order to enforce such lien against other creditors or encumbrances.

KANSAS.—Material men and mechanics have lien for labor and materi l on the land and improvements to the extent of their claims. The original contractor must file his claim within four months; all other persons claiming a lien, within two months after the debt accrued. This lien has precedence over all other liens or encumbrances placed on the property subsequent to the commencement of the building or improvements.

KENTUCKY.—There is a general law for the State (not applying to Jefferson county, which has a special act in some respects different) giving mechanics and material men liens upon the improvements and interest of the employer in the land for work done and material furnished. Sub-contractors and laborers may acquire a lien, by giving the employer written notice of their claim, and that they look to the land and improvements for compensation. Liens must be filed in sixty days and suit brought in six months, to enforce claims, or they are lost.

LOUISIANA.—The contractor has a lien for the payment of his labor on the building or other work which he may have constructed. Workmen employed immediately by the owner in the construction or repair of any building have the same privilege. If the contractor be paid by the employer, actions for work and supplies furnished the former will not lie against the latter, but moneys due the contractor by the employer may be seized and applied towards payment. No agreement for work exceeding $500, unless reduced to writing and registered with the recorder of mortgages, shall be privileged as above. For amounts less than $500, this formality is dispensed with, but the privilege is limited to 6 months from the time of completed work. Workmen employed on vessels or boats have a lien on the same, and are not, in any case, bound to reduce their contracts to writing, but their privilege closes if they allow the vessels to depart without exercising their right.

MAINE.—Mechanics have a lien on buildings for labor and materials furnished for erecting or repairing same, which may be enforced by attachment in ninety days after same are furnished or labor done, and against vessels for four days after same is launched.

MASSACHUSETTS.—Any person furnishing labor or materials for the erection, alteration or repairs of any building, shall have a lien on the same, but no lien for the materials shall attach unless he shall notify the owner, in case he is not the purchaser, in writing, that he intends to claim a lien for the same before they are furnished. Where the contract for furnishing labor and materials is

for an entire sum, a lien will attach for the labor, if its value can be ascertained separate from the materials, but not beyond such entire sum. Notice in writing from the owner of such building, that he will not be responsible for the labor and materials to be furnished to the party furnishing or performing the same, will prevent the lien from attaching.

MARYLAND.—Every building erected, and every building repaired, rebuilt or improved to the extent of one-fourth of its value, shall be subject to a lien for the payment of all debts contracted for work done or material furnished for or about the same; also vessels, boats or machines constructed or repaired within this State are subject to mechanics' lien. The lien must be filed in the record office within six months after the work has been finished or materials furnished. If the contract shall have been made with an architect or builder, or any person other than the owner of the ground on which the building is erected, or his agent, notice of intention to claim a lien must be given to the owner within sixty days. The mechanics' lien has priority over all other liens or encumbrances placed on the property after the commencement of the building, and over mortgages to secure future advances, where the loan or advance is not actually made until after the commencement of the building.

MISSISSIPPI.—Judgments when enrolled, are liens on all property in the county where rendered; may be made liens in any county having abstract enrolled there. Mortgages and deeds in trust are also liens. They must be acknowledged and recorded in the same manner as ordinary deeds of conveyance. Mechanics have a lien for labor done and materials furnished in the erection and repair of buildings, but suits to enforce a mechanic's lien must be commenced in six months.

MICHIGAN.—Any person who shall, by contract with the owner, part owner or lessee of any piece of land, furnish labor or materials for constructing or repairing any building, wharf, or appurtenances on such land, has a lien therefor upon said building, wharf, machinery, appurtenances, the entire interest of said owner, part owner or lessee in and to said land not exceeding one-quarter section; or if in the limits of an incorporated village or city, in the lot or lots on which said building, wharf, machinery or appurtenances are situated, to the extent of his claim. He must file a verified certificate with the register of deeds, containing a copy of the contract, if in writing, or if not a statement of its terms, with a description of the land, and a statement of the amount due and to become due, with all credits to which the owner may be entitled.

The owner, part owner or lessee must be notified of the filing of the certificate. In order to have the benefit of the lien, proceedings to foreclose must be taken within six months after the last installment shall become due. A sub-contractor has a lien to the extent of the interest of the original contractor, upon complying with substantially the same provisions as in case of an original con-

tractor. Mechanics, workmen, and other persons, also have a lien in certain cases, for performing labor or furnishing materials in building, altering, repairing, beautifying or ornamenting any house or other building, machinery or appurtenances to any house or building.

MISSOURI.—Material men and mechanics have lien for labor and material on the land and improvements to the extent of their claims. The original contractor must file his claim within six months, laborers within thirty days, and all other persons claiming a lien within four months after the debt accrued. This lien has precedence over all other liens or encumbrances placed on the property subsequent to the commencement of the building or improvements.

NEW JERSEY.—Persons who perform labor or furnish materials for the erection and construction of buildings, have a lien on the same for such labor and materials, including the lot on which such buildings are erected; *provided*, the lien is filed in one year after the labor is performed or materials furnished, and the summons issued in the year.

NEVADA.—Persons who perform labor or furnish materials for the erection or improvement of any building has a lien on the same for such work and materials for all amounts over $25. And so have all laborers on all work done by them on any railroad, toll-road, canal, water-ditch, mine or mining-shaft, or tunnel, or building lot in a city or town; *provided*, the original contractor shall file his lien in sixty days, and the sub-contractor or laborer in thirty days after the work is completed, and suit commenced in six months.

NEBRASKA.—Any person who shall have performed any labor, or furnished any material or machinery for the erection, reparation or removal of any house or other building or purtenances, by virtue of a contract, expressed or implied, with the owner thereof, or his agent, shall have a lien thereon to secure the payment for such labor performed or materials furnished. Said lien shall be obtained by filing, in the office of the county clerk for record, an account, in writing, of the items, and making oath thereto, within four months after furnishing such materials, or work and labor. The lien shall operate from the date of the first item till two years from the date of the last item.

NEW HAMPSHIRE.—Laborers and persons furnishing materials have a lien on the building and on the land on which it is put, to the amount of $15, and for the space of sixty days after the labor was performed or materials furnished.

NORTH CAROLINA.—All laborers, material men and mechanics have liens on the houses built, improved or repaired by them, and on the lots on which they are built, to the extent of the interest of the party who had the improvements or repairs done. But they must take the necessary steps to enforce this lien, by

filing same and bringing suit within ninety days after the work is finished.

NEW YORK.—The laws on this subject are not uniform throughout the State. Material men and mechanics have lien for labor and materials on land improvements to the extent of their claims. The claim must be filed within thirty days after completion of labor and furnishing of materials; and in the county of New York, and some other counties, within three months. The lien continues for one year.

OREGON.—Contractors for material or labor on any building have, from the time work is commenced thereon, a lien on the building and the ground on which it is situated, prior to all other liens on the same premises placed thereon after the commencement of work on the building. Suits must be brought within six months after payments are due under the contract, but no credit given on payments can extend the lien beyond two years from the completion of the work. The lien extends in favor of the workmen to the extent of the contract price; if before payments are due, they give written notice of their intention to hold the owner. And no payments made to the contractor before they are due under the contract, can defeat this lien.

OHIO.—Material men and mechanics, whether they be contractors, sub-contractors or laborers, may have a lien upon the buildings erected, and the land on which the buildings are erected, if within four months of the completion of the labor or furnishing of the materials they file an account, under oath, of their claim, in the county recorder's office. This account must be itemized. If the work be done or materials furnished under a written contract, such contract, or a copy thereof, must be filed with the account. The lien thus obtained dates back to the commencement of the labor or the furnishing of materials, and extends to two years after the completion of the labor or the furnishing of materials.

PENNSYLVANIA.—These bind houses and lands from the date of the commencement of work on the building (usually the cellar digging); for all work done and materials furnished toward the erection and construction of the building; *provided*, a lien for the same be filed within six months after the work has been done or the materials furnished. Liens may also be filed for alterations or repairs; they bind the property from the date of filing.

The debts of a deceased person are a lien on his real estate for 5 years after his death; the lien may be continued by suit brought within that time. The lien of judgments operates for 5 years from date of entry, when they must be revived by *scire facias*. The lien of a mortgage for purchase money is good from date of mortgage if rendered within 60 days; other mortgages from date of record.

RHODE ISLAND.—Mechanics have a lien for labor, or labor combined with materials furnished, which, in the case of an

original contractor, must be prosecuted within six months, and in case of a sub-contractor or day laborer, within thirty days after commencing the work; but no landlord is bound for the improvements made by the tenant, nor a married woman, under any circumstances, unless the contract is in writing, assented to by them, and is clearly intended to bind them.

SOUTH CAROLINA.—All persons who furnish materials or perform labor in the erection, improvement or repairing of buildings, have a statutory lien on the same, to the extent of the interest of the party who had the buildings erected or improvements done; *provided*, that within ninety days after he ceases to labor a proper account be filed with the clerk of the court and suit thereon be begun in six months.

TEXAS.—Any person or firm who may labor, furnish material, machinery, fixtures and tools to erect any house, improvement, or any improvement whatever, shall have a lien on such article, house, building, fixtures or improvement, and also on the lot or lots or land necessarily connected therewith, to secure payment for labor done, material and fixtures furnished for construction or repairs. Such person or firm shall, within six months after such debt become due, file his contract in the office of the district clerk of the county in which the property is situated, and have the same recorded in a book kept for that purpose by the clerk. If the contract, order or agreement be verbal, a duplicate copy of the bill of particulars must be made under oath, one to be filed and recorded by the clerk as provided for written contracts, the other to be served on the party owing the debt. When the contract or account is filed and recorded, they must be accompanied by a description of the property against which the lien is claimed. The filing and recording fixes a lien from the day it is filed. The lien, if against land in the country upon which said improvements have been made, shall extend to and include fifty acres; if in a city, town or village, it extends to and includes such lot or lots upon which said improvements are situated. The lien may be enforced against the land and improvements, or the improvements alone. The purchaser having a reasonable time to remove the same. The sale to be upon judgment and order of sale. This lien extends as well to homesteads as to other property; also, to all boats navigating the waters of this State. All actions to enforce liens must be brought within two years.

TENNESSEE.—Material men, contractors and mechanics who furnish work or materials to aid in the construction or repair of any building or buildings, shall have a lien on the same for one year after the work is done, provided notice in writing of said lien be first given to the owner, or his agent at the time said work is begun, or materials furnished. All debts incurred for repairing, fitting, building, navigating, or furnishing steam or keel boats, shall be a lien on such vessels provided suit be commenced within three months from the time the debt is incurred.

VERMONT.—Material men and mechanics have a lien for labor and material in building, repairing, fitting or furnishing any vessel until eight months after such vessel is completed. It may be secured by attachment, and has precedence of all other claims. They also have lien upon a building, and the lot on which it stands, for erecting or repairing such building. The lien continues three months after payment comes due, but does not attach until the person claiming it has filed and caused to be recorded, in the town clerk's office, a written memorandum, by him signed, asserting such claim.

VIRGINIA.—All artisans, builders, mechanics, lumber dealers and others performing labor or furnishing materials for the construction, repair or improvement of any building or other property, are allowed a lien upon such property for the work done and materials furnished. It must be asserted by suit within six months from the time the lien is secured.

WEST VIRGINIA.—A mechanic or workman or any person who shall perform any labor upon or furnish material to erect, repair, alter or improve any building, has a lien on the same, which can be enforced by suit in chancery in six months; *provided*, he filed his account under oath with the clerk of the county court in thirty days after the work was done or material furnished.

WISCONSIN.—All persons who perform labor upon or furnish materials for the building, improving or repairing of buildings, have a lien thereon for the same, which must be enforced by filing a petition for the lien in six months in the circuit court and an action to foreclose in one year.

ONTARIO.—Mechanics, laborers and material men have a lien on buildings and on the land on which said buildings are situate, for work or materials furnished for erecting or repairing same. Lien can be secured by filing statement of the claim in the registrar's office within 30 days after the completion of the work. It will cease to hold good after the expiration of 90 days.

There is no lien law proper in any of the other Provinces of Canada.

Schedule of Architects' Charges,

AS ADOPTED BY THE AMERICAN INSTITUTE OF ARCHITECTS, NEW YORK.

For full professional services (including superintendence), 5 per cent. on the cost of the work.

Partial service as follows:

For preliminary studies, 1 per cent.

For preliminary studies, general drawings and specifications, $2\frac{1}{2}$ per cent.

For preliminary studies, general drawings, details and specifications, $3\frac{1}{2}$ per cent.

For stores, 3 per cent. upon the cost, divided in the above ratio.

For works that cost less than $5,000, or for monumental and decorative work, and designs for furniture—a special rate in excess of the above.

For alteration and additions—an additional charge to be made for surveys and measurements.

Necessary travelling expenses to be paid by the client.

The architect's payments are successively due as his work is completed, in the order of the above classifications.

Until an actual estimate is received, the charges are based upon the proposed cost of the works, and the payments are received as instalments of the entire fee, which is based upon the actual cost.

Drawings, as instruments of service, are the *property of the architect.*

SCALE OF PROFESSIONAL CHARGES GENERALLY ADOPTED BY ARCHITECTS AND ARCHITECTURAL SURVEYORS IN GREAT BRITAIN.

Commission on the Cost.

Public buildings and private residences	5	per cent.
Block of 2 houses of similar design	4	" "
Block of 3, 4 or 5 houses of similar design	3	" "
Block of 6 or more houses of similar design	$2\frac{1}{2}$	" "
Stores and warehouses	4	" "
Block of 2 or more stores or warehouses, of similar design	3	" "
Block of 3 or more stores or warehouses of similar design	$2\frac{1}{2}$	" "
Detailed drawings	1	" "
General superintendence (exclusive of clerk of the works) examining and passing the accounts (exclusive of measuring and making out extras and omissions	$1\frac{1}{2}$	" "

N. B.—The following subdivision of charges to apply proportionately to stores, warehouses, etc.

For the work in the alterations of premises, the remuneration to be increased according to the time, skill and trouble involved:

Taking out quantities from plans for detailed estimate	$1\frac{1}{4}$ per cent.
Measuring and valuing artificers work done for any amount under $1,000	2 " "
Over $1,000 and under $4,000	$1\frac{1}{2}$ " "
Over $4,000	$1\frac{1}{4}$ " "
For services by time, per day	$10

N. B.—Travelling expenses extra. No charge to be made for a rough estimate obtained by cubing out its contents. If a detailed estimate be requested by the proprietor a charge therefor is to be made as above.

An architect is bound under the full percentage charge to provide one set of drawings and one set of tracings, with duplicate specifications; it being understood that the architect is paid for the use only of the drawings and specifications and that these, in the event of his carrying out the works to completion, are to remain his property.

1. Preliminary sketches and designs complete, including survey of site, etc	$1\frac{1}{4}$ per cent.
2. General drawings, plans, elevations and sections, specification and approximate estimate	$1\frac{1}{4}$ " "
3. Working and detail drawing	$1\frac{1}{4}$ " "
4. Personal supervision and superintendence (exclusive of clerk of works)	$1\frac{1}{4}$ " "
Total charge,	5 " "

NOTE. The above charge of 5 per cent. is to be estimated on the value of the work executed including such materials and labor as may be supplied by the owner; omitted work is to be paid under items 1, 2 and 3, according to the stage of the proceedings at which the alteration was determined upon.

Procuring and examining tenders for the work, ... $\frac{1}{2}$ per cent. in addition to the foregoing:

Arranging with artists, tradesmen and others for sculpture, stained glass and works of a similar class, for which the architect does not furnish the designs; but to which he gives a general supervision,	$2\frac{1}{2}$ per ct. on the value.
Alterations in the design, extra labor in attending committee meetings, arranging disputes with adjoining owners, etc	$15.00 per day.
Travelling and incidental expenses	extra.

Measuring up works, and certifying the builder's accounts for extras and omissions, from 2½ to 1½ per cent., according to the description of building.

An architect is bound under the 5 per cent. charge to provide one set of drawings and one set of tracings, with duplicate specifications; it being understood that the architect is paid for the use only of the drawings and specifications, and that they remain his property at the completion of the work.

Payment on account, at the rate of 5 per cent., to be made on the instalments paid to the builders, or otherwise to half the commission on signing of the contract, and the remainder by instalments as above.

DISTRICT SURVEYORS FEES WHEN ATTACHED TO A CORPORATION.

For New Buildings.

For every building not exceeding 400 square feet in area, and not more than two stories in height.......................$7.50
For every additional story.................................... 1.25
For every additional square of 100 feet or fraction of such square... .75
But no fee shall exceed.......................................50.00

Fees for Alterations and Additions.

For every addition made to any building after the roof thereof has been covered in, the fee shall be half of the fee charged in the case of a new building.

For inspecting the arches or stone doors over or under public ways..$2.50
For inspecting the formation of openings in party walls...... 2.50
For inspecting dangerous structures by direction of the commissioners of police or sewers........................ 5.00

Architectural Surveyors Fees.

The charge for measuring in small new buildings, and in repairs, including a bill of the particulars is......2½ per cent.
In large new works of a plain character the usual charge is..1½ " "

When the works are of elaborate construction the charge will vary from 1½ per cent. upwards, according to the additional trouble entailed in measuring.

For works of very small value the charge is by the day.

Estimating quantities from plans and specifications and preparing the "bill of quantities" for very small or difficult works the charge is.................2½ per cent.
Ditto, for ordinary works of $50,000 value, or under....1½ " "
Ditto, above $50,000, the first $50,000 being charged under the last item..................................1 " "

Lithographing and traveling expenses are charged extra.

In important works, where the quantities are taken out conjointly, by two different surveyors, half of the above rates are due to each surveyor. In large works of very plain character, especially when many simple repetitions occur, lower rates than the foregoing are sometimes considered sufficient.

Scales of Charges for Valuations as adopted by eminent London Firms.

On the first $500	5 per cent.
" second $500	$2\frac{1}{4}$ " "
" third to tenth $500	1 " "
Above $5,000	$\frac{1}{2}$ " "
The first thousand being charged at the rate of	$1\frac{1}{2}$ " "
Minimum rate charged by architects and architectural surveyors when paid by the day	$15

FORM OF CONTRACT FOR BUILDING.

Made the —— day of————, one thousand eight hundred and ———, by and between ————————, of the second part, in these words; the said —— part ——— of the second part *covenant*, and *agree* to and with the said party of the first part, to make, erect, build, and finish, in a good substantial, and workmanlike manner, on the ———————————————— agreeable to the draft, plan, and explanation hereto annexed, of good and substantial material, by the ——— day of ——— next. And the party of the first part covenants and agrees to pay unto the said ——— part ——— of the second part, for the same, the sum of ————————————————, lawful money of the United States, as follows: The sum of ——————————, and for the true and faithful performance of all and every of the covenants and agreements above mentioned, the parties to these presents bind themselves each unto the other, in the penal sum of——————— dollars, as affixed and settled damages to be paid by the failing party.

In witness whereof, the parties to these presents have hereunto set their hands and seals, the day and year above written.

Sealed and delivered in the presence of ———————.

Leading Architectural and Building Journals.

The American Architect and Building News. Published weekly by James R. Osgood & Co., 211 Tremont St., Boston. Price, $7.50 per year, or $6.00 if paid in advance.

The Builder and Wood-Worker. Published monthly by Chas. D. Lakey, 176 Broadway, New York. Price, $1.00 per year.

Carpentry and Building. Published monthly by David Williams, 83 Reade Street, New York. Price, $1.00 per year.

The California Architect and Building News. Published monthly by Messrs. J. & G. Wolfe, 240 Montgomery Street, San Francisco, California. Price, $2.00 per year.

Building. Published monthly by Wm. T. Comstock, 6 Astor Place, New York. Price, $1.00 per year.

A GLOSSARY

OF ARCHITECTURAL TERMS.

Aaron's-Rod.—An ornamental figure representing a rod with a serpent twined about it. It is sometimes confounded with the *Caduceus* of Mercury. The distinction between the Caduceus and the Aaron's-Rod is that the former has two serpents twined in opposite directions, while the latter has but one.

Abaci.—Supposed by Vitruvius to mean panels in the stucco of walls and used as a decoration above the dado.

Abaciscus.—A square compartment enclosing a part, or the entire pattern or design of mosaic pavements.

Abacot.—*In decoration.* A coronet or cap of state.

Abacus.—The upper member of the capital of a column. It is sometimes square and sometimes curved, forming on the plan segments of a circle, called the Arch of the Abacus and is commonly decorated with a rose or other ornament in the centre—having the angles, called *horns* of the Abacus cut off in the direction of the radius or curve. In the Tuscan or Doric, it is a square tablet; in the Ionic, the edges are moulded; in the Corinthian, its sides are concave and frequently enriched with carving. In Gothic pillars, it has a great variety of forms.

Abutment.—That part of a pier from which the arch springs. *Sand pier*—sometimes the facing of masonry of this pier.

Abuttals.—The boundings of a piece of land on other land, street, river, etc.

Abreuvoir, is the joint between two stones, or the interstices left to be filled up with cement.

Abraxes.—*In decoration.* The name of small gems or statues having figures of beetles, serpents, etc., with human heads, etc.

Acanthus.—A plant whose leaves are carved on the Corinthian and Composite capital. They are differently disposed, according to circumstances; and the leaves of the laurel and parsley are sometimes employed in their place.

Acanthines.—*In decoration.* A border or fillet ornamented with leaves of the acanthus.

Accessories.—Those parts or ornaments in architectural composition, whether designed or accidental, which are not apparently essential either to the use or character of a building.

Accident.—An effect or combination in architectural composition which was not foreseen, a deviation from regularity or symmetry not foreseen—often taken advantage of by the architect to improve the composition of his designs.

Accompaniment.—Buildings or ornaments having a necessary connection or dependence, and which serve to make a design more or less complete.

Accouplement.—*Among carpenters.* A tie or trace.

Accerra.—*In decoration.* Vases made like a box in which the ancients put perfume and incense.

Acroterium.—A pedestal on the angle or apex of a pediment, intended as a base for sculpture.

Adit.—The approach to a building, a doorway—also an air shaft.

Admeasurement.—Adjustment of proportions; technically an estimate of the quantity of materials and labor of any kind used in building.

Advanced work.—*In military architecture.* A work constructed beyond the covered way or glacis of a fortress.

Advanced-Fosse.—*In militia architecture.* A ditch thrown across the esplanade; a glacis to prevent a surprise by besiegers.

Adytum.—A retired or sacred place in ancient temples which only the priest was allowed to enter.

Ædes.—*In ancient Roman architecture.* A small temple dedicated to worship.

Ædicula.—A diminutive temple dedicated to a deity.

Ægis.—*In decoration.* A breastplate or shield.

Ægricanes.—Sculptured representations of the heads and skulls of rams, which are used as decorations on alters, friezes, etc.

Ægypteria.—*In decoration.* A species of Egyptian ornaments having a light blue figure or device on a dark ground.

Ælamoth.—A vestibule.

Ælurus.—*In Egyptian ornaments.* The god cat.

Ætoma.—A pediment; the *tympanum* of the pediment.

Affection.—*In architectural composition.* An unnatural or overstrained imitation or artifice.

Agalma.—The ornaments upon a statue or within the temple.

Agger.—*In ancient military architecture.* A military road formed into a ridge.

Agger.—A wall or dike erected against a sea or river to keep it within bounds—a dam.

Agger.—A mound or funeral burrow raised upon graves—a tumulus.

Agora.—An ancient market or forum.

Aile, Aisle.—The wings, inward side porticos of a church, the inward lateral corridors which enclose the choir, the presbytery, and the body of the church along its sides.

Air trap.—An opening for the escape of air from drains.

A la Grecque.—One of the varieties of the fret ornament.

Alabastrites.—A box or base used by the ancients for holding perfumes.

Albarum opus.—A sort of plastering composed of pure lime used by the ancients for incrusting baths and making cornices.

Alcove.—A recess in a bedroom in which a bed is placed—a recess fitted up with seats—an ornamental garden building for shade or rest.

Alipterion.—*In ancient Roman architecture.* A room used by bathers for anointing themselves.

Alley.—An aisle of the church—a narrow walk.

Almehrabh.—*In Arabian architecture.* A niche in a mosque marking the direction of the temple at Mecca.

Almonry, Almery.—A cupboard closet or recess for setting aside broken victuals for the poor—a stone house near a church from which alms were distributed.

Altar.—*In ancient Roman architecture.* A place on which offerings or sacrifices were made to the Gods.

Altar of incense.—A small table covered with plates of gold on which was placed the smoking censer in the temple at Jerusalem.

Altar.—Among Romish Christians, a square table placed at the east end of the church for the celebration of mass.

Altar-piece.—The entire decorations of an altar, a painting placed behind an altar.

Altar-screen.—The back of the altar from which the canopy was suspended, and separating the choir from the lady chapel and presbytery. The altar-screen was generally of stone, and composed of the richest tabernacle work of niches, finials and pedestals, supporting statues of the tutelary saints.

Alto-relievo.—High relief—a sculpture, the figures of which project from the surface on which they are carved.

Ambitus.—A space around every tomb which was considered to be sacred.

Ambo.—A raised platform, a pulpit, a reading desk, a *marble* pulpit—an oblong enclosure in ancient churches, resembling in its uses and positions the modern choir.

Ambry.—A cupboard or closet, frequently found near the altar in ancient churches to hold sacred utensils.

Ambulatory.—An alley—a gallery—a cloister.

Amphiprostylos.—A Grecian temple which has a columned portico on both ends.

Amphitheatre.—A double theatre, employed by the ancients for public amusements, generally of an elliptical form, such as the colosseum. In landscape gardening an elevated terrace, having steps descending to a series of terraces formed on the sloping sides of a hill.

Amphithete.—*In decoration.* A drinking cup of a large size, often seen in Greek sculptures.

Amphora.—A Grecian vase with two handles, often seen on medals.

Anchor.—An ornament like an arrow-head, used in all orders of architecture, but particularly in the ovolo echinus, where it forms a combination with the *egg.*

Andron.—A Grecian hall for men onlv to dine in.

Ancones, or Trusses.—Ornaments in the cornices of an Ionic door-way, resembling medallions placed vertically.

Angels.—*In mediæval architecture.* Brackets or corbels with the figures or heads of angels.

Angle-Bar.—*In joinery.* An upright bar at the angles of polygonal windows, a mullion. *See bay window.*

Angle-Brace.—A piece of timber fixed on two sides of a quadrangular frame, forming the area of the frame into an octagonal opening.

Angle-Bracket.—A bracket placed in the vertex of the angle, and not at right angles with the sides.

Angle-Head.—*See angle staff.*

Angle-Capital.—*In Greek architecture.* Those Ionic capitals placed on the flank columns of a portico, which have one of their volutes placed horizontally at an angle of a hundred and thirty-five degrees with the plane of the frieze.

Angle-Modillion.—*In ancient Roman architecture.* A modillion placed in a direction parallel to a diagonal drawn through the mitre of the cornice.

Angle-Rafter.—*In carpentry.* A piece of timber, of a carved form, placed between those parts of an arched ceiling where the planes, if continued, would form an angle, and corresponding with the common ribs when they are placed in a vertical direction, or to receive and support them when they are in a horizontal direction.

Angle-Staff, Angle-Bead.—A piece of wood placed vertically, and fixed upon the exterior or salient angles of apartments.

Angle-Tie.—*In carpentry.* Dragon piece.

Angular Capital.—The modern Ionic capital, having the four

sides alike, and showing the volute, placed at an angle of one hundred and thirty-five degrees in all the faces.

Annulated Columns.—Columns clustered together by rings or bands; much used in English architecture.

Annular Vault.—A vault rising from two circular walls—the vault of a corridor.

Annulet.—A small square moulding used to separate others. The fillet which separates the flutings of Ionic capitals is sometimes known by this term.

Anta, Antæ.—Properly the jams of doors, or square posts supporting the lintel. Small pillars attached to walls forming the entrance of edifices in general. They have capitals differing from those of the columns to which they are attached. Also, an insulated square pillar without base or capital or any other moulding.

Ante-chamber.—An apartment preceded by a vestibule and from which is approached another room.

Ante-chapel.—That part of the chapel through which the passage is to the choir.

Antefragmenta.—The three pieces constituting the frame of a doorway.

Antependium.—An awning or veil, which was suspended over and before the altar in mediæval churches.

Anterides.—*In ancient architecture.* Buttresses or counterforts supporting a wall.

Ante-sigma.—*In Roman furniture.* A semicircular table bed, which when joined to another formed a round table.

Ante-temple.—What is now called the nave of a church.

Antics.—*In architecture.* Fancies having no foundation in nature, as sphinxs, centaurs, etc., different flowers growing on one stem. Grotesque ornaments of all kinds.

Ante-ficæ.—Upright blocks ornamented on the face and placed at regular intervals on the crowning member of a cornice.

Antiquarium.—A room or cabinet where ancient books and vases were kept.

Apodyterium.—A room at the entrance of ancient baths, where persons dressed or undressed for the bath, or practiced gymnastic exercise.

Apateichismus.—*In ancient military architecture.* A double wall or rampart of earth raised by the besiegers close to the place invested.

Apotheca.—A cabinet, cupboard, cellar, etc., in which the ancient Romans kept oils, wines, etc.

Apothesis.—A place on the south side of the chancel in ancient churches, fitted up with shelves for books, vestments, etc.

Apophorata.—A movable stage or bar to carry relics.

Apoplyge-Apothesis.—A concave quadrantal moulding, joining the shaft of a column to the base, and connects the top of the shaft to the fillet under the astragal. The small fascia or bend at the top and base of the shaft of columns.

Apsis.—The bowel or arched roof of a house, room, or oven—the canopy of a throne—the inner part of ancient churches where the clergy were seated and where the altar was placed.

Apron-piece.—*In carpentry.* A horizontal piece of timber in a wooden double-flighted stair supporting the carriage pieces and joistings in the half spaces of landings.

Apron-Lining.—*In joinery.* The facing of the apron-piece.

Apostoleum.—A church called by the name of an apostle.

Apteral.—A temple which is built without columns at the sides.

Arabesque.—A building after the manner of the Arabs. Ornaments used by the same people in which no human or animal figures appear. Arabesque is sometimes improperly used to denote a species of ornaments composed of capricious fantastics and imaginary representations of animals and foliage so much employed by the Romans in the decorations of walls and ceilings.

Arabian Architecture.—A style of architecture, the rudiments of which appear to have been taken from surrounding nations, the Egyptians, Syrians, Chaldeans, and Persians. The best preserved specimens partake chiefly of the Græco-Roman, Byzantine, and Egyptian. It is supposed that they constructed many of their finest buildings from the ruins of ancient cities.

Araignee.—*In military architecture.* A branch return, or gallery of a mine.

Aræostyle.—That style of building in which the columns are distant from one another from four to five diameters. Strictly speaking, the term should be limited to inter columniation of four diameters, which is only suited to the Tuscan order.

Arbores.—Large bronze candelabra, in the shape of a tree, placed on the floor of ancient churches, so as to appear growing out of it.

Arca Custodiæ.—*In Roman Architecture.* A kind of cage or cell, with bars of oak, for confining criminals.

Arcade.—A series of apertures or recesses with arched ceilings or soffets. A series of arched openings round public squares, markets, courts, etc.

Arcæ.—*In Roman Architecture.* The gutters of the Cavedium.

Arcæ Arculæ.—In square sarcophagi, sides expanding, and resting upon feet resembling a lion.

Arc-Boutant.—An arched buttress formed of a flat arch or part of an arch, abutting against the feet or sides of another arch to support them. They are sometimes called flying buttresses.

Arcella.—*In mediæval Architecture.* A cheese-room.

Arch.—*In building.* A mechanical arrangement of building materials arranged in the form of a curve, which preserve a given form when resisting pressure, and enables them, supported by piers or abutments, to carry weights and resist pressure.

Arch-buttress.—Sometimes called a flying buttress; an arch springing from a buttress or pier.

Architecture.—The art of building—it is divided into three classes, civil, military, and naval.

Architrave.—That part of an entablature which rests upon the capital of a column, and is beneath the frieze.

Architrave of a door.—A collection of members surrounding the aperture—the upper part of the lintel is called the traverse and the sides the jambs.

Architrave Cornice.—An entablature consisting of an architrave and cornice, without the intervention of the frieze, sometimes introduced when inconvenient to give the entablature the usual height.

Archives.—A repository or closet for the preservation of writings or records.

Archivolt.—A collection of members forming the inner contour of an arch, or a band or frame adorned with mouldings running over the faces or the arch-stones, and bearing upon the imposts.

Arcs-Doubleaux.—The soffits of arches.

Arcuature.—The bending or curvature of an arch. The intrados.

Arcus.—The avenue or area in front of the ancient Basilicæ.

Arcus Ecclesiæ.—*In mediæval Architec'ure.* The arch by which the name of the church was divided from the choir or chancel.

Area.—The superficial contents of any figure—an open space or court within a building.

Arena.—The plain space in the middle of the Amphitheatre or other place of public resort.

Arena.—*In Architecture.* The middle or body of a temple.

Arriere-boussure.—A rear vault—an arch placed within the opening of a window or door and of a different form to increase the light.

Arris.—The meeting of two surfaces producing an angle.

Arris fillet.—A triangular section of timber used in raising slates against shafts of chimneys, and similar work.

Arsenal.—A public storehouse for arms and ammunition.

Artificer or **Artizan.**—A person who works with his hands, and manufactures any commodity in iron, brass, wood, etc.

Arx.—*In Ancient Military Art.* A fort or castle, for the defence of a place.

Asarotum.—A kind of painted pavement used by the Romans before the invention of Mosaic work.

Ashlar, or ashler.—Common, or free stones as they are brought from the quarry, generally from 9 to 12 inches thick, but of different superficial dimensions. When the facing of the stones is quite smooth, and exhibit no marks of the tools by which they were cut, it is called *plane Ashler*. When wrought in a regular manner so that the surface has the appearance of parallel flutes, placed vertically it is called *tooled Ashler*. When the surfaces of the stones are cut with a broad tool without care or regularity, it is said to be *random tooled*. When wrought with a narrow tool, *chiselled or boasted*. When cut with very narrow tools it is said to be *pointed*, and when the stones project from the joints with either smooth or broken surfaces, the ashlar is said to be *rusticated*. Neither pointed, chiselled nor random tooled ashlar can be admitted in good work. The act of setting an ashlar facing is called *ashlaring*.

Ashlaring.—*In carpentry* The fixing of short upright quarterings in garrets about two feet and a half or three feet high, between the rafters and the floor, cutting off the acute angles at the bottom.

Asphaltum.—A kind of bituminous stone, principally found in the province of Neufchatel. Mixed with stone it forms an excellent cement incorruptible by air and impenetrable by water.

Assemblage.—The uniting of things together as by mortice and tenon, dovetailing, etc.

Assemblage, or association of the orders, the placing of the columns one upon another so that their axes may be in the same straight line.

Astel.—A board or plank used for partitioning over head in tunnelling.

Astragal.—A small semicircular moulding, sometimes plain and sometimes ornamented.

Asymptote.—A straight line which continually approaches to a curve without touching it.

Attached Columns.—Those which project three-fourths of their diameter from the wall.

Atlases or **Atlantides.**—Statues of men which supported entablatures with mutules.

Atrium.—A court surrounded by pictures in the interior division of Roman houses.

Attic.—A low story erected over an order of architecture to finish the upper part of the building, chiefly used to conceal the roof.

Attic, or Atticurgic Base, consists of an upper and lower torus, a scotia, and fillets between them.—A small height of panelling above the cornice.

Attic Order.—A term used to denote the low pilasters employed in the decoration of an attic story.

Attributes.—In *painting* and *sculpture.* Symbols given to figures and statues to indicate their office and character.

Auditory.—*In ancient churches.* That part of the church where the people usually stood to be instructed in the gospel, now called the *nave.*

Aviary.—A large apartment for breeding birds.

Aula.—A court or hall in ancient Roman houses.

Axis.—The spindle or centre of any rotative motion. In a sphere an imaginary line through the centre.

Back.—When a piece of timber is placed in position, the upper side is called the back and the lower the breast.

Back-fillet.—*See Annulet.*

Back Shutters.—The part folded behind; the division that is visible is called the front.

Back of a window.—That piece of wainscoting which is between the bottom of the sash frame and the floor.

Backing of a Rafter or Rib.—The forming of an upper or outer surface, that it may range with the edges of the ribs or rafters on either side.

Backing of a Wall.—The rough inner face of a wall. Earth deposited behind a retaining wall, etc.

Badigeon.—A mixture of plaster and free-stone, well sifted and ground together, used by statuaries to fill up small holes and repair defects.

Bagnio.—An Italian term for a bath.

Baguette.—A small astragal moulding, sometimes carved and enriched with pearls, ribands, and laurels.

Ball-flower.—Gothic, an ornament resembling a ball enclosed in a circular flower—one of the characteristics of the decorated style.

Balaneia.—A Greek term for a bath.

Balcony.—A projection from the face of a wall supported by columns or consoles, and usually surrounded by a balustrade.

Baldachin.—A building in the form of a canopy, supported with columns, and serving as a crown or covering to an altar.

Balks.—Large pieces of timber.

Balloon.—A round ball or globe placed at the top of a pillar or spire by way of a crowning.

Baluster.—A small pillar or column, supporting a rail, of various forms—used in balustrades.

Baluster.—The lateral part of the volute of the Ionic capital.

Balustrade.—A series of balusters connected by a rail.

Band.—A flat or square member or moulding, smaller than the facia.

Banded Column.—A column encircled with bands, or annular rustics.

Bandelet.—Any little band, or flat moulding, that encompasses a column like a ring.

Banker.—A stone bench on which masons cut and square their work.

Banquet.—The footway of a bridge, raised above the carriageway.

Bars of a sash.—Light pieces of wood or metal which divide the window-sash into compartments for panes.

Bar-Posts.—Posts driven into the ground to form the sides of a field gate. They are mortised to admit of horizontal bars being put in or taken out at pleasure.

Barbacan.—A long narrow canal or opening left in walls of a building erected on a place liable to be overflowed with water, to allow it to flow through. *In ancient fortification*, an outer defence to a fortification.

Barge Board.—Boards nailed against the outer face of a wall, along the slopes of a gable end of a house to hide the rafter, etc., and to make a neat finish.

Barge-Course.—That part of the tiling which projects over the gable of a building and is made up below with mortar.

Bas-relief.—*See basso-relievo.*

Basalt.—A stratified rock very useful in building, paving, etc.

Base Mouldings.—The mouldings immediately above the plinth of a wall, pillar or pedestal.

Base of a Column.—That part which is between the shaft and the pedestal, or if there be no pedestal, between the shaft and the plinth. The Grecian Doric had no base, and the Tuscan has only a single torus or a plinth.

Basement.—The lower part of a building.

Basil.—A word used by carpenters to denote the angle to which the edges of iron tools should be ground.

Basilica.—A kind of public hall or court of justice—when applied to a church it conveys an idea of great magnificence.

Basin.—A small reservatory of water, as in fountains—a dock.

Basket.—A kind of vase in the form of a basket filled with flowers or fruits, serving to terminate some deeoration.

Basse-Cour.—A court separated from the principal one and destined for stables, etc.

Basso-Relievo or Bas-Relief.—The representations of figures projected from a back ground without being detached from it. It is divided into three parts, *alto-relievo*, when the figure projects more than one-half, *mezzo-relievo*, that in which the figure projects

one-half; and *basso-relievo*, when the projection of the figures is less than one-half, as in coins.

Bat.—A part of a brick.

Batten.—Small scantlings used in the boarding of floors and on walls for lathing on.

Batten-door.—A ledged door, or barred door.

Batter.—When a wall is built in a direction that is not perpendicular to its base, it is said to batter.

Battlements.—Indentations on the top of a parapet or wall, first used in fortifications, and afterwards applied to churches and other buildings for ornaments.

Battifolium.—A kind of tower of defence mentioned by Latin historians.

Baulk.—A piece of timber from 4 to 10 inches square.

Bay.—Any kind of an opening in a building, as a door, window or chimney.

Bay of Joists.—The joisting between two binding joists, or between two girders, when there are no binding joists.

Bay of roofing.—The small rafters and purlins between the principal rafters.

Bay window.—*See bow window.*

Bazar.—A kind of Eastern mart, of Arabic origin.

Bead.—A circular moulding. When several are joined, it is called *reeding*; when flush with the surface, it is called *quirk-bead*, and when raised, *cock-bead.*

Bead and Butt Work.—A piece of framing in which the panels are flush, having beads run or stuck on both edges, having the grain of the wood in their direction.

Bead, Butt and Square Work.—Framing with bead and butt on one side, and square on the other.

Bead and Flush Work.—A piece of framed work with beads run on each edge of the included panel.

Bead, Flush, and Square Work.—Framing with bead and flush on one side, and square on the other.

Bead and Quirk.—A bead stuck on the edge of a piece of stuff, flush with its surface, with only one quirk, or without being returned on the other surface.

Beak.—A small fillet in the under edge of a projecting cornice, intended to prevent the rain from passing between the cornice and fascia.

Beam-Filling.—The building of masonry or brickwork, between rafters and wall plates, etc., to fill up spaces.

Bearer.—Anything which supports a body in its place, as a wall, post, strut, etc.; a vertical support.

Bearing of a piece of timber.—That part of a piece of timber which is unsupported, or is between two or more props.

Bearing.—The length between bearers or walls; thus, if a bearer rests on walls twenty feet apart, the bearing is said to be twenty feet.

Bearing Wall, or partition.—A wall which is built upon the solid, and made to support another wall or partition, either in the same or a transverse position. When the supported wall is built in the same direction as the wall it supports, it is said to have a solid bearing, but when built in a transverse direction, or not supported throughout its length, a false bearing.

Beaufet, or Buffet.—A small cupboard, or cabinet, to contain china.

Beds of a Stone.—The horizonital courses of a wall of masonry; that under any particular stone, is called the *underbed.*

Bed-mouldings.—Ornamental mouldings on the lower face of a projecting cornice.

Belection Mouldings.—Mouldings which project around the panels of a framing; seldom used, except in external decorations to very grand houses.

Bell-gable.—*Gothic.* In small churches and chapels, a kind of turret placed on the apex of a gable at the west end, and carrying a bell.

Belfry.—That part of a steeple in which the bells are hung.

Bell.—*Of the Corinthian and Composite Orders.* It is used to denote the body of the Capital by reason of its shape to an inverted bell.

Bell-Roof.—Somewhat similar in its curves to a bell.

Belt.—A course of stones projecting from a brick or stone wall, generally placed in a line with the sills of the first floor window, it is either moulded fluted, plane or enriched with patras at regular intervals. Sometimes called stone string.

Belvedere or Look out.—A turret or lantern raised above the roof of an observatory for the purpose of enjoying a fine prospect.

Benda.—*See Fascia.*

Bevel angle.—A term used by workmen to denote any angle besides those of 90 or 45 degrees.

Billet moulding.—*See Moulding.*

Binding joists.—Beams arranged on a floor at from 3 to 4 feet apart to support transversely the bridgings above and the ceiling joists below.

Binding rafters.—*See Purlins.*

Birds mouth.—An interior angle, made in the upper end of a piece of timber to shore up bressummers.

Bitumen.—*See Asphaltum.*

Blank-door.—A false door placed in an apartment opposite to the real door for the sake of uniformity.

Blank windows.—Used similarly as a blank-door.

Blinds.—There are different blinds in use. The improved *Venetian* worked on rollers are very suitable for rooms.

Blocking or blocking-course.—*In Masonry.* A course of stones placed on the top of a cornice crowning the walls.

Blockings.—*In Joinery.* Small pieces of wood fitted and glued to the interior angle of two boards or other pieces with a view to strengthen the board.

Boarding joists.—Joists in naked flooring to which the boards are fixed.

Boarding Luffer.—*See Luffer boards and Lever boards.*

Boasting-tool.—*See Tools by Masons.*

Boasting.—*In stone cutting.* The paring of a stone with a broad chisel and mallet.

Bolection moulding.—Mouldings in framed work which project beyond the surface of the framing.

Bolsters of the Ionic capital—*See Baluster.*

Bond.—The disposition of stones or bricks in a building. The crossing of another stone or brick over the vertical joint of one beneath it.

Bond-timbers.—Timbers placed in a horizontal direction in the walls of a building in tiers, and in which the battens, laths, etc., are secured. In rubble work, walls are better plugged for this purpose.

Bonds.—This general term includes the whole of the timbers that are disposed in a wall as bond-timbers, wall plates, lintels and templates.

Bond-heart.—When two stones placed in a horizontal position extend the exact thickness of wall and another is put over the joint in the centre of the wall; this is called heart-bond.

Bond-stones.—Stones used in uncoursed rubble-walling having their length placed in the thickness of the wall; when inserted the whole thickness of the wall they are called perpend-stones.

Boning.—The act of lining out with pickets, a street or wall, or making a plane surface by the art of the eye.

Border.—Useful ornamental pieces of wood round the edge of anything.

Boss.—A projection in shape of a segment of a sphere, or somewhat so whether for use or ornament, often carved or cast.

Boultive.—A convex moulding, an *ovolo*.

Boutant.—An arch boutant is an arch or buttress, serving to sus-

tain a vault, and which is itself sustained by a strong wall or pile. *A pillar boutant* is a pile of stone to support a wall or vault.

Bow.—Any projecting part of a building in the form of an arc of a circle. A bow, however, is sometimes, polygonal.

Bow-Window.—A window placed in the bow of a building.

Bowtel.—The shaft of a clustered pillar, or any plain, round moulding.

Boxings of a Window.—The cases in which shutters are folded. *Pulley Boxes,* the boxes in which the window pulleys are suspended.

Brace.—A piece of timber placed in an inclined position, and used in partitions or roofs. *See Truss and angle braces.*

Bracket.—A support for shelves, or pieces under the ends, steps of stairs for ornament only.

Branched Work.—The carved and sculptured ornaments in panels, friezes, etc., composed of leaves and branches.

Brandering.—Covering the underside of joists with small battens to nail the laths to for plastering.

Break.—A projecting part of the front of large buildings.

Break-joint.—One stone placed on the joint of two stones in the course below to form a perfect bond.

Breast of a Window.—The masonry forming the back of the recess and the parapet under the window sill.

Breeze.—Small ashes and cinders, made use of instead of coals for the burning of bricks.

Bressummer.—A lintel, beam, or iron tie, intended to carry an external wall and itself supported by by-piers or posts; used principally over shop windows.

Brick.—Brickwork between quarterings.

Bridge-board.—A board into which the ends of wooden steps are fastened.

Bridge-over.—A piece of timber fixed over several parallel pieces in a transverse direction. The common rafters, for example, bridge over the purlins; and in naked flooring the upper joists to which the flooring-boards are nailed, are called the flooring-joists.

Bridge-Stone.—A stone laid in a horizontal direction over an area extending from the pavement to the entrance door of a house and not supported by an arch.

Bridge-Gutters.—Gutters made with boards, supported beneath with bearers and covered above with metal.

Bridging-Floors.—*See naked flooring.*

Bridging-Joists.—Pieces of timber, or joists in naked flooring, extending in a direction parallel with the girder and supported by bearers called binding joists which lie in a transverse direction.

Bridges, or Bridging-Pieces.—*See straining-pieces and strutting-pieces.*

Bridge up or carrying up.—A term analogous to building up; *i.e.*, building up a wall so many feet.

Brooch.—A painting all in one color.

Bulwark.—*In ancient fortification.* Nearly the same as bastion in modern.

Bundle-Pillar.—*Gothic.* A column consisting of a number of small pillars round its circumference.

Burca.—A Turkish term for the rich covering of the door of the house of Mecca.

Burgward.—The same as bulwark.

Bursa.—*In Middle Age Writers.* A little college or hall in a university for the residence of students.

Burse or Bourse.—A public edifice for the assembly of merchant traders,—an Exchange.

Bust.—*In Sculpture.* That portion of the human figure which comprises the head, neck and shoulders.

Bustum.—A figurative expression among the Romans for any kind of tomb.

Butments or Abutments.—Supports or props by which the feet of arches are sustained in their places.

Butment Cheeks.—The two solid parts on each side of mortise.

Butt-Joint.—In hand-railing, a joint at right angles to the curve of the rail.

Buttery.—A store room for provisions.

Butting.—*Joint.* A joint formed by the surfaces of two pieces of wood, the surface of one being parallel with the other's fibres, and that of the other either in the same or an oblique direction.

Buttress.—A mass of masonry or brickwork serving to support the side of a wall that is of a great height, or to assist it in sustaining any great strain or pressure upon it from the opposite side.

Buttress.—*Gothic.* Are used for ornament as well as strength. Two kinds are used—one called *pillared:* buttresses formed of vertical planes attached to the walls; and the other, which rises from the pillared buttresses upon the sides of the aisle, with an arch-formed intrados, and sloping intrados or top, and called *flying buttresses or arc boutants.*

Byzantine Architecture.—A style devoloped in the Byzantine Empire. The capitals of the pillars are of endless variety and full of invention; some are founded on the Greek Corinthian, some resemble the Norman and the Lombard style, and so varied that no two sides of the same capital are alike. They are comprised under the style Romanesque, which comprehends the round arch style.

Cabinet.—The most retired room in a building, set apart for writing, studying, or preserving anything valuable. Also, a highly ornamented kind of buffet or chest of drawers set apart for the preservation of things of value.

Cabinet.—*In Gardening.* A little insulated building or kind of summer-house, open on all sides, and serving as a place of retirement.

Cable.—A moulding in the lower part of a fluted column, represented by a rope or rush lying in the fluting. These columns are called cable-fluted.

Cage.—An outer work of timber enclosing another within it.

Caissons.—Sunk panels in ceilings or in soffits.

Calcareous Cement.—*See Cements.*

Caldarium.—A brazen vessel in ancient baths in which hot water was kept. Also, a close vaulted room in which sweating was produced by dry hot fumes.

Caliber, or Calliper.—The diameter of any round body. The width of the mouth of a piece of ordnance.

Caliducts.—A kind of pipes or canals disposed along the walls of houses and apartments, and used by the ancients for the conveyance of heat from one common furnace.

Calotte.—A concavity or depressure in the form of a cup or niche, lathed and plastered to diminish the height of a chapel, cabinet or alcove, which would otherwise be too high for the breadth.

Camarosis.—An elevation terminating with an arched or vaulted head.

Camber.—An arch on the top of an aperture, or on the top of a beam, hence camber-windows.

Camber-Beam.—A piece of timber cut with an obtuse angle on the upper edge, so as to form a declivity on each side, or cut in a convex form.

Campana.—The body of the Corinthian capital on which the leaves were placed, called the vase or bell.

Campanile.—A tower allotted for bells. In Italy being separate from the churches.

Canal.—The flutings of a column or pilaster.

Canal of the Volute.—A spiral channel in the Ionic capital, commencing at the eye and expanding in width until the whole number of revolutions are completed.

Canal of the Larmier.—A channel or groove recessed on the soffit of the larmier upwards, to prevent the rain water from running down the lower part of the cornice.

Canardiere.—A small turret sometimes erected at the salient

angle of works to serve as a shelter for a sentinel, and formerly to protect warriors from exposure to the enemy.

Cancelli.—Latticed windows. Also, balusters or rails which compass a court of justice, communion table, or the like.

Candalabrum.—Stands or supports on which the ancients placed their lamps. Candalabra were made in a variety of shapes and with much taste and elegance.

Canopy.—A magnificent canopy or altar, throne, pulpit, chair or the like. *In Gothic.* The projecting moulding that surrounds the arches and heads of the Gothic niches.

Cant.—An external angle or corner of a building, also a term amongst carpenters to turn over a beam of timber.

Cant-Mouldings.—A moulding with a bevelled face.

Cantilever.—Blocks of wood, or iron, projecting at regular distances from the surface of a wall to support the eaves of a house, or upper mouldings of a cornice. It is essentially the same with modillion; but the latter work is confined to general architecture.

Cantharus.—A fountain in the middle of the atrium before the ancient churches, wherein persons washed their heads and faces before they entered.

Canting.—The cutting away a part of an angular body at one of its angles, that the section may form a parallelogram, whose edges are parallel from the intersection of the adjoining planes.

Cantined.—When the angles of a building are adorned with columns, pilasters, rustic quoins, or anything which projects beyond the naked walls.

Cap.—*In Joinery.* The part which crowns the whole, as the capital of a column, cornice of a door, etc., etc.

Capeduncula.—Vessels wherein the ancient Romans preserved the sacred fire of Vesta.

Capital.—The head of a column which rests on the shaft.

Capital of a Lantern.—The covering which terminates the lantern of a dome.

Capping-pieces.—A general name for horizontal timbers, which extend over upright posts and into which the posts are framed.

Capital of a Triglyph.—The projecting band above the plane vertical area or face. In the Grecian Doric, the capital of the triglyph, projects only a short distance, and is not returned on the flanks, except at the angular triglyphs, and this only upon each face of the building. In the Roman Doric, it has a greater projection, and is returned with the same projection on the flanks as on the face.

Caravansera.—A huge square building, or inn, in the East, for the reception of travellers and lodging of caravans.

Carasole.—A spiral staircase.

Carcass.—The shell or ribs of a house before it is lathed and plastered, or the boards are laid.

Carrara Marble.—The white marble of the ancients. It is distinguished from Parian, now called statuary marble, by being harder and less bright.

Carrel.—*In the middle ages.* A closet for privacy and retirement.

Carriage.—The timber work which supports the steps of a wooden stair.

Carton, or Cartoon.—A design made on strong paper, to be transferred on the fresh plaster wall to be afterwards painted in fresco; also a colored design for working in Mosaic tapestry, etc.

Cartouche.—An ornament resembling a scroll of paper, being usually in form of a table, or flat member, with wavings, bearing some inscription or device. It is nearly akin to a modillion with this exception, that the cartouche is used only externally, whilst the modillion is used both internally and externally, as under the cornice in the eaves of a house.

Caryatic Order.—An order of architecture wherein the entablature is supported by female figures clothed in long garments, instead of columns.

Case-Bags.—The joists that are framed between a pair of girders in naked flooring. When the joists are framed, with one of their ends let in the wall, they are called *tail bags.*

Cased.—A term which signifies that the outside of a building is faced or covered with materials of a better quality.

Cased Sash Frames.—Sash frames having their interior vertical sides hollow to conceal the weights by which the sashes are hung.

Casemate.—A hollow moulding.

Casement.—A glass frame which is made to open by turning on hinges, affixed to its vertical edges.

Cassine.—A country house; a house surrounded by a ditch, like those of the old feudal barons.

Cast.—A term used in sculpture for the impression of any figure taken in plaster of Paris, wax or other substances.

Castella.—*In Roman Antiquity.* A reservoir of water.

Casting.—*In carpentry.* A term analogous to warping

Castrum Doloris.—A lofty tomb of state.

Catabasion.—*In the Greek Church.* A place under the altar where the relics are kept.

Catacombs.—Subterraneous places for burying the dead, those of Egypt are believed to be most important.

Cataconum.—The want of height proportionate to the breadth of the chapter of a pillar.

Catadrome.—A machine used by builders to raise and let down great weights.

Catafalco.—An ornamental scaffold used in funeral solemnities.

Catagrapha.—In ancient ornamental workmanship, figures of men's faces represented as viewed obliquely.

Catch Drains.—The feeders of reservoirs. In the construction of canals, the same as counter-drains.

Cathedral.—The head church of a diocese.

Catherine Wheel.—*Gothic.* An ornamental window of a circular form, with rosettes, or radiating divisions, of different colors.

Cathetus.—A perpendicular line, passing through a cylindrical body, as a baluster, or column.

Cattus.—A movable shed usually fixed on wheels.

Cavædium.—In ancient buildings, an open court.

Cavasion.—The foundation plan of the walls of a building.

Cave.—One of the oldest species of architecture of which we have any remains are the excavations in rocks, supposed to be intended for religious worship.

Cavea.—The den or caves in ancient amphitheatres.

Cavetto.—A concave ornamental moulding, opposed in effect to the ovolo—the quadrant of a circle.

Caulicoles.—Slender stems or stalks under the leaves of the abacus in the Corinthian Capital—between each pair of the uppermost leaves, eight stalks branch out into two leaflets, seeming to support the sixteen volutes, of which four are on each side of the abacus.

Causeway.—A raised or paved way.

Caustic Curve.—Formed by the collected rays of light issuing from a curved reflector.

Cella.—The sanctuary or interior of a temple.

Celtic Architecture.—Consisted of rude and non-durable buildings or huts, in the midst of a thick wood, and fortified by a high bank and a ditch.

Cement.—Consists of various adhesive compositions for the mason, plasterer and joiner.

Cenotaph.—An honorary tomb or monument, distinguished from monuments in being empty, the individual it is to memorialize having received interment elsewhere.

Centaur.—A poetical imaginary being of heathen mythology, half man and half horse.

Centering.—*In Building.* The frame on which an arch is turned.

Centres of a door.—The two pivots round which the door revolves.

Ceroma.—In the gymnasia and Roman baths, an apartment where the bathers and wrestlers were anointed with oil and wax.

Cerophastic.—The art of modelling in wax.

Cestophorus.—Sculptures of females bearing the cestus or marriage girdles in the marriage ceremonies of the ancients.

Chain-timber.—A piece of timber, in breadth equal to the length and breadth of a brick used for strengthening walls by inserting in the middle height of a story.

Chambraule.—An ornamental bordering on the sides and tops of doors, windows and fire places; this ornament is generally taken from the architrave of the building.

Chamfer.—To channel or make indentures in stones, pillars, or other ornamented parts of a building.

Chancel.—That part of a church at the eastern end, in which the altar or communion table is placed; usually separated from the nave and transept by cancelli or lattice work.

Chandeliers.—Are wooded parapets, used in fortifications for defence.

Channel.—A part in the Ionic capital, somewhat hollow under the abacus, after the listel, it lies upon the echinus having its contours or turnings upon each to make the volutes. *Channel stones* are stones prepared for gutters.

Chantlate.—A piece of wood fastened near the end of a rafter, projecting beyond the wall to support two or three rows of slates to prevent rain from running down the walls.

Chantry.—A little chapel in ancient churches, for the performance of mass for the release of souls in purgatory.

Chapel.—A place of public worship separate from or attached to a church.

Chapiters with mouldings.—Are the capitals of the Tuscan and Doric orders which are without foliage or embellishment.

Chapiters with sculptures.—Are the Corinthian, and those decorated with foliage and other carvings.

Chaplet.—An ornamental fillet in the form of a string of beads.

Chapter House.—The place where canonical meetings are held usually attached to a cathedral house.

Charged.—Implies that one member of a piece of architecture is sustained by another. A frieze is said to be charged with the ornament with which it is charged.

Charnel House.—A house for the deposit of the bones of the dead.

Chartophyacium.—A recess for the preservation of records.

Chase Mortise.—The mode of inserting or mortising inclined transverse joists into paralled timbers in ceilings.

Cheeks.—Two equal and similar parts of any piece of timber work.

Chequers.—Stones of uniformly equal dimensions arranged in the face of a wall with uninterrupted lines of vertical and horizontal points.

Cherub.—*Gothic.* A representation of an infant's head joined to two wings used in the churches or keystones of arches and corbels.

Chevron.—*Gothic.* An ornament turning this and that way like a zigzag or letter Z.

Chain Moulding.—An ornament of the Norman period—in imitation of a chain.

Chiaro-Oscuro.—The effects of light and shade in a picture *In architecture* it is not dependent on the laws of perspective, and exemplified in the drawing of the bisection of an edifice to display the internal conveniences, the number and proportions of the various apartments, and the thickness of the walls.

Chimney piece.—The ornaments consist of architraves, friezes, cornices, columns, pilasters, termini, caryatides, consoles and almost every appropriate emblishment.

Chinese architecture.—Consists principally of Towers and Pagodas; their architecture is as peculiar as the people and differs from every other nation.

Church.—A building for the performance of public worship; the first were built on the plan of ancient Basilicæ; this style was followed by the *Gothic*, a church is said to be in *Greek Cross* when the length of the transverse is equal to that of the nave; *in Latin cross*, when the nave is longer than the transverse part; *in Rotundo* when it is a perfect circle; *simple*, when it has only a nave and choir; with *aisles*, when it has a row of porticos in form of vaulted galleries, with chapels in its circumference.

Ciborium.—A small arched vault supported by four columns. The sculptured tombs of martys are called ciboriums; also the coffer case enclosing the host.

Cilery.—Ornaments of foliage and drapery on the heads of columns.

Cimbia.—A list, string, fillet or cincture.

Cimeliarch.—A name given to the apartment where the plate and vestments are deposited in church.

Cincture.—The circular concavity near the head or base of a column.

Cinquefoil.—*Gothic.* A five-leaved ornament, in circular and other divisions of the windows of ancient churches, and also on panels. It is a rosette of five equal leaves.

Cippus.—The cippi were small columns by the sides of highways,

generally bearing inscriptions of remarkable events, or used as land marks. They were frequently without capital or base.

Circumvallation.—The surrounding of trenches or fortifications with a trench or parapet, commonly flanked with redoubts.

Circumvolutions.—A term applied to the spirals of the volute of the Ionic capital, which in some instances has three, but in the temple of Minerva Polias four circumvolutions.

Circus.—Among the Romans a large oval building, for the exhibition of popular games and shows.

Civic Crown.—A garland of oak leaves and acorns, given as honorary distinction among the Romans to such as had preserved the life of a fellow citizen.

Clathri.—In Roman architecture, bars of iron or wood used to secure doors, etc.

Clear.—The uninterrupted distances between two places.

Clere-Story Windows.—Such as have no transom intersection.

Clepsydra.—A vessel or building used by the ancients to measure time, by running out a certain quantity of sand or water.

Clinkers.—Bricks impregnated with nitre, and hard burnt.

Cloacæ.—The common sewers of ancient Rome.

Cloister.—*Gothic.* The principal part of a regular monastery, consisting of square piazza between the church and the chapter house and the refectory, having over it the dormitory, and often enclosing the cemetery.

Close String.—In dog-leg stairs, a stair case without an open newel.

Closer.—The last stone in the horizontal length of a wall, which is smaller than the rest, to fill up the row.

Clough.—A paddle or sluice in a pond or canal.

Clough Arches, or Paddle Holes.—Crooked arches by which the water is conveyed from the upper pond into the chamber of the lock of a canal on drawing up the clough.

Clustered.—In architecture, the coalition of several members which penetrate each other.

Clustered Column.—Several slender pillars attached to each other, so as to form one. The term is used in Roman architecture to denote two or four columns which appear to intersect each other at the angle of a building to answer at each return.

Cockle Stairs.—A winding staircase.

Cock-Head.—See Bead.

Cocking or Cogging.—A mode of notching timber.

Cœnaculum.—The eating-room of the Ancient Romans.

Cœnateo.—A banqueting and summer house of the ancient Romans.

Coffer.—A recess used anciently in level soffits, and on the intrados of cylindrical vaults. In Roman works the panel at the bottom is generally covered with a rosette. They are also used between the modillions in the soffit of the cornices. Coffer, also a substitute for a canal lock.

Coffer DAM.—A frame used in the building of a bridge in deep water, similar to a caisson.

Collar Beam.—A beam above the lower ends of the rafters.

Colonelli.—The posts of a truss frame.

Colonnade.—A row of columns. The colonnade is termed according to the number of columns which support the entablature: Tetrastyle, when there are four; hexastyle when six; octostyle when eight, etc. When in front of a building they are termed porticos; when surrounding a building peristyle, and when double or more, polystyle.

Colosseum or Coliseum.—The immense amphitheatre built at Rome by Flavius Vespasian, A. D. 72, after his return from his victories over the Jews. It would contain ninety thousand persons sitting, and twenty thousand more standing.

Colossus.—The name of a brazen statue which was erected at the entrance of the harbor at Rhodes, 105 feet in height. Vessels could sail between its legs.

Column.—A round pillar. The parts of the *base* on which it rests; its body called the *shaft;* and the head called the *capital.* The capital finishes with a horizontal table called the abacus, and the base commonly stands on another called the plinth.

Corna.—In antiquity, a mound of earth over a grave.

Comitium.—A building in the Roman Forum wherein assemblies of the people were held.

Commissure.—The joint between two stones.

Common.—A line, angle surface, etc., which belongs equally to several objects. Common centering is a centering without trusses, having a tie beam at bottom. Common joists are the beams in naked flooring to which the joists are fixed. Common rafters in a roof are those to which the laths are attached.

Compartition.—The distribution of the ground plan of an edifice into rooms and passages.

Compartment Ceiling.—A ceiling divided into panels, surrounded with mouldings.

Compluvium.—A void space in the centre of Roman buildings, to receive the waters that fall from the roof; also the gutter or eaves.

Composite Order.—*See Order.*

Composite Arch, is the pointed or lancet arch.

Concamerata Sudatio.—An apartment in the ancient gymnasium

where the wrestlers and racers retired to wipe the sweat from their bodies.

Concamerate.—To arch over.

Concatenate.—To link together.

Concave.—Hollow.

Concentric.—Having a common centre.

Conclave.—The place in the Vatican where the Cardinals meet to choose a pope.

Concretion.—The hardening of soft bodies.

Conduit.—A long narrow passage between two walls or underground for secret communication between different apartments, also a canal or pipe for the conveyance of water.

Configuration.—The exterior superficies of a body.

Conisterium.—An apartment in the gymnasium of the ancients where the wrestlers sprinkled themselves with dust after being anointed with oil, that they might take the surer hold of each other.

Conservatory.—A building for the protection of tender plants, often attached to a house, as an apartment.

Consistory.—The judicial hall of the college of cardinals at Rome.

Console.—An ornament cut on the key-stone of an arch, sometimes in the form of a scroll or human face.

Contorted.—Wreathed.

Contour.—The outline of a body.

Contramure.—In fortification, an external wall to protect the wall it encloses.

Contravallation.—*In Fortification,* a trench guarded by a parapet raised beyond musketshot by the besieged.

Coping.—The upper tier of masonry which covers a wall. There is *parallel, feather edged* and *saddle back* coping.

Corbels.—*Gothic.* A row of stones projecting from a wall to support the parapet, serving in the place of brackets or modillions. Also a piece of timber projecting from a wall and usually carved with some grotesque figure.

Corbel-table.—A series of semicircular arches which cut one another in a wall, supported by timbers with their ends projecting out and carved into heads, faces, lion's heads, etc.

Cordon.—The edge of a stone at the outside of an edifice.

Core.—The interior of a wall. *Corinthian order.*

Cone-bracketting.—The wooden skeleton mould or framing of a cone, applied chiefly to the bracketting of a cone ceiling.

Coned-ceiling.—A ceiling springing from the walls with a curve.

Corona.—The brow of the cornice which projects over the bead mouldings to throw off the water.

Corridor.—A long gallery or passage in a mansion connecting various apartments and running round a quadrangle.

Cortile.—The court yard of Italian houses, often embellished with statues.

Coned and flat ceiling.—A ceiling in which the section is the quadrant of a circle, rising from the walls and intersecting in a flat surface.

Counter-fort.—A pier or buttress to strengthen a wall.

Countersink.—To make a cavity in timberwork for the reception of a plate of iron, or the head of a screw or bolt.

Coupled columns.—Columns arranged in pairs.

Course.—A continued layer of bricks or stones in buildings; the term is also applicable to slates, arch stones, etc.

Court.—An open area behind a house, or in the centre of a building and the wings. Courts admit of the most elegant ornamentations, such as arcades, etc.

Cousinet or cushion.—The stone which is placed on the impost of a pier to receive the first stone of an arch, also the name of the front of an Ionic capital between the abacus and echinus.

Crab.—An instrument to raise large stones.

Cradle.—The same as coffer.

Cradling.—Timber work for sustaining the lath and plaster of vaulted ceilings, or for sustaining an entablature for a shop front etc.

Crampoons.—Hooked pieces of iron for drawing up timber or stones.

Chapandine-doors.—Such as turn at the top and bottom.

Chenell.—*Gothic.* The opening of an embattled parapet.

Crescent.—A building erected in the form of an arc.

Crest-tile.—The tile on the ridge of a house. *In Gothic architecture,* leaves running up the sides or gable, or ornamented canopy.

Crenellated mouldings.—Mouldings embattled, notched or indented. Used in the Norman style.

Crests.—Carved work on the top of a building. The ridges of roofs, the copes of battlements and the tops of gables were called crests.

Creux.—That species of sculpture in which the lines and figures are cut below the surface.

Crocket.—*Gothic.* The small buds or bunches of foliage used to ornament spires, canopies, pinnacles, etc., the large bunches at the top being termed finials.

Croissante Croix.—A crescent at each end.

Cross-banded.—A term applied to a veneer on a hand-rail, the grain of which crosses that of the rail.

Cross-beam.—A large beam going from wall to wall or a girder that holds the side of the house together.

Cross-vaulting.—A common name given to groins and cylindrical vaults.

Crown.—The upper part of a cornice including the corona. The ornaments on the key stone of an arch, called also a console.

Crosettes.—The returns on the corners of architraves of doors, etc.

Crypt or Croud.—A subterraneous vault generally beneath churches. In late years used for burial.

Crypt porticus.—Subterraneous galleries in the Roman Villas used as cool sitting-rooms.

Culmen, of the Romans, was the ridge piece of the roof.

Culvert.—An arched drain for conveying water under canals or roads.

Cunette.—*In fortifications.* A deep trench to obstruct an enemy's approach.

Cupola.—A spherical vault at the top of an edifice, a dome.

Curb-plate.—The wall plate of a circular ribbed dome, also the horizontal rib of the top, etc.

Curb roof or Mansard roof.—A roof formed of four contiguous planes, each two having an external inclination.

Curator.—The names given by the Romans to surveyors or inspectors of public works.

Curia.—The Roman council house.

Curtail step.—The first step in a stair, which is generally finished in the form of a scroll.

Curtain.—*In Fortification.* That part of a rampart which lies between two bastions.

Cushion capital.—A capital having a resemblance to a cushion.

Cusp.—*Gothic.* A term applied to pendants, assembled they form trefoils, quatrefoils, etc.

Cut.—A canal. *Brackets* are *cut* when they are moulded on the edge. A *cut-roof*, is a truncated one.

Cyclopean Buildings, are the most ancient specimens of masonry, formed by immense blocks of stone piled upon each other without cement.

Cylindric Ceiling.—A ceiling vaulted in the shape of a segment of a cylinder. Cylindrical ceilings admit of being pierced by lunettes, which form cylindro-cylindric arches. They should be

decorated with coffers, separated by soffits and enriched with guilloches.

Cyma.—A moulding with an undulating or waved profile, partly convex and partly concave, called by workmen an ogee. When the hollow part is uppermost, it is called a cyma-recta; when the convex part is above a cyma-reversa; when it is the upper moulding of a cornice it is called cymatium.

Cymatium.—The upper moulding of a cornice of three kinds of cymatia, the *Tuscan* is supposed to have been an ovolo, or quarter round; the Doric an ovolo or cavetto, and the *Lesbian* the cyma inversa.

Cyzigenus.—A magnificent hall among the Greeks.

Dado.—The square or flat part of the base of a column between the plinth and the cornice. It is of a cubical form.

Days or Bays.—*In Gothic Architecture.* The compartments formed in tall windows by the intersection of mullions.

Decastyle.—A portico temple or other building with ten columns in front.

Declination, of the Doric mutules.

Decorated-style.—The second of the Pointed or Gothic style of architecture considered the most complete and perfect development of Gothic architecture.

Decoration.—Anything that enriches or gives beauty to a church or other buildings.

Demi-Metope.—The half of a metope, which is found at the retiring or projecting angles of a Doric frieze.

Dentels, or Dentils.—Square blocks introduced as ornaments into cornices, chiefly of the Ionic and Corinthian orders, in the form of identations or teeth; a small circular piece is sometimes cut out, and at other times they are fluted.

Diaglyphic.—A species of sculpture in which the strokes, or lines, are indented, opposed to the usual mode in which figures are prominent.

Diameter.—The line in a circle passing through its centre, or thickest part, which gives the measure proportioning the intercolumniation in some of the order.

Diaper.—Ornament of sculpture in low relief, sunk below the general surface, or of painting, or of gilding, used to decorate a panel, or other flat recessed surface.

Diamond-fret.—A decorated moulding, consisting of fillets intersecting each other, used in Norman architecture.

Diastyle.—A term applied to a building with columns at the distance of three diameters from each other.

Diathyra.—The vestibule before the door of a Grecian house.

Diatonic Stones.—Cubical stones with two wrought faces, used by ancient builders as angle or corner stones. They were as broad as the thickness of the wall.

Die.—A square cube.

Dieglyph.—A double channeled tablet.

Diminished Arches.—Arches less, or lower than a semicircle.

Dipteron.—A temple with a double row of columns.

Discharge.—The relief given to a beam, or a piece of timber, overcharged by too great an incumbent weight of building; when built under it is said to be discharged.

Discharged Arches.—Are those built over wooden lintels, by which the bearing upon them is taken off. The cords of discharing arches are not much longer than the lintels. A temporary lintel is sometimes inserted, which is afterwards removed.

Dishing out, or Cradling.—Wooden vaultings or covered ribwork, for plastering upon.

Disposition.—*In Architecture.* Is understood to mean the proper situation and arrangement of the apartments, entrances, etc. It is divided into plan, elevation and perspective view. The term embraces every particular relating to the purpose of an architectural design.

Distemper.—Term applied to painting with colors mixed with size or other glutinous substance. All the cartoons of the ancients, previous to the year 1410, are said to be done in *distemper.*

Ditriglyph.—The intervening space between two triglyphs in intercolumniations over the intercolumn, so that a triglyph being placed over each of two outermost columns, will form the ditriglyph containing three metopes, or spaces two whole triglyphs, and two half triglyphs.

Dividicula.—*In Ancient Architecture.* The basin which received the water from an aqueduct.

Dodecastyle.—A portico having twelve columns in front.

Dogs-tooth Moulding.—An ornamental member of early English architecture. It has no resemblance to its name.

Dome.—An arched or vaulted roof, springing from a polygonal, circular or elliptic plan. When the base is circular, it is termed a *cupola*; when a polygon it is a polygonal dome; and when an ellipsis an elliptic dome, the central point in the curved surface is called the pole.

Domestic Architecture.—That branch which relates to private buildings.

Donjon.—The massive tower in the interior of ancient castles, to which the garrison might retreat in case of necessity.

Doric Order.—The oldest of the three orders of Grecian architecture, and the most original.

Dormer Windows.—Windows of dormitories, or sleeping rooms, on the inclined plane of the roof.

Double Vault, formed by a duplicate wall; wine cellars are sometimes so formed.

Dove-tail Moulding.—Used in Norman Architecture.

Dragon-Piece.—The name given to a piece of timber joined to what is called, on roofs, the *diagonal tie.*

Draught, or Drawing.—Architectural composition, or design, is understood to be a necessary mode of conveying instructions to the practical builder and the workmen, by exhibiting a comprehensive view of a projected building; drawings for this purpose must be executed with clearness and precision, conformable to a regular scale of proportions. Plans, elevations, and sections are to represent the internal features of the apartments, halls, passages, and various arrangements for ornament or convenience, and the external facades, porticos, domes, and other outward appendages. Drawings of the smaller parts of an edifice will be required numerous in proportion to their extent and variety of form. Where the façades of a building differ considerably, elevations of each of them will be required, and more than one general view of the projected building will be necessary to give satisfaction to the proprietor.

Draw-bridge.—A bridge made to draw up or let down, much used in fortified places. In navigable rivers, the arch over the deepest channel is made to draw or revolve, in order to let the masts of ships pass through.

Dressing.—Is the operation of squaring and smoothing stones for building.

Dressing.—Ornamental projections from walls, of various descriptions, as architraves, borderings, and facings of doors and apertures.

Drift.—Applied to arches, synonymous to *shoot* and *thrust,* intended to express the powerful impetus of the arch against the pier.

Drip.—A name given to the member of a cornice which has a projection beyond the other parts for throwing off water by small portions, drop by drop. It is also called *larmier.*

Dripping-Eaves.—Are the terminating projections of inclined roofs, to which there is no gutter.

Drip-Stone.—The label moulding which serves on a canopy for an opening and to throw off the rain. It is also called weather moulding.

Dromus.—An enclosed entrance to ancient buildings.

Drops.—Ornaments of a conical form in the Doric entablature, resembling bells placed immediately under the triglyphs—six under each.

Droved Ashlar.—The coarsest kind of hewn stone for building.

Druidical Architecture.—Circles of unwrought upright stones, known as Druidical temples.

Drum.—The solid part of the capitals of the Corinthian and Composite orders, from its form called *vase.*

Dwarf-Wall.—The walls enclosing courts-above which are railings of iron; low walls in general, receive this name.

Eagle.—A Greek term for the frontispiece, or pediment of their temples.

Eaves.—The overhanging edges of a roof.

Eaves Lath, or Eaves Board, or Eaves Catch.—An arris fillet, or thick feather-edged board at the eaves to raise the first course of slates so that the next course may be properly bedded.

Echinus.—A convex moulding, generally ornamented with spheroid eggs, the upper ends cut off, the upper part of the axis projecting and the lower receding. Each egg is surrounded by a border and is rather more than a semi-ellipsis. The Roman echinus is the quarter of a circle, and is inferior to the Greek. In a column, the echinus is only used in the entablature or capital, and in the Doric order it is always plain, whilst in the Ionic and Corinthian, it is generally carved.

Edging.—The reducing of edges of rafters, that they may range together.

Edifice, is synonymous with the terms, building, fabric, erection, but is more strictly applicable to architecture distinguished for size, dignity and grandeur.

Effect.—*In Architecture.* The result of the sensations produced when the whole parts of an edifice are put together. Nothing is more deceptive than simple delineations which architects make of their works. High artistic designs of a building, frequently lead to great disappointment when the building is completed, therefore all designs should be in simple colors, India ink or sepia, and finished with very little shading or pictorial effect. Often architects of great experience, are deceived in the effect to be produced. In important works, small models in relief, will give some idea of the proportion of the different projecting parts to each other, and to the whole edifice.

Egg and Tongue are ornaments sculptured in the echinus and Ionic volutes.

Egyptian Architecture.—The earliest civilization and cultivation of the arts was in Upper Egypt. The most remarkable and most ancient monuments of the Egyptians with the exception of the pyramids, are nearly all included in Upper Egypt. The buildings of Egypt are characterized by solidity and massiveness of construction, originality of conception and boldness of form. The walls, the pillars and the most sacred places of their religious buildings, were ornamented with hieroglyphics and symbolical figures, whilst the ceilings of the porticos exhibited zodiacs and

celestial planispheres. The temples of Egypt were generally without roofs and consequently the interior colonnades had no pediments, supporting merely an entablature, composed of only architrave frieze cornice, formed of immense blocks united without cement and ornamented with hieroglyphics.

Ellipse.—That curve called by workmen an oval.

Elevation.—A geometrical projection drawn on a plane perpendicular to the horizon.

Embattled, or indented with notches, in form of embrasures, and on the top of a wall or parapet of a castle.

Emblemata.—A kind of inlaid work used by the Romans to embellish panels, floors, etc.

Embossing.—Sculpture in relievo, the figures standing partly out from the plane.

Embrazure.—The enlargement of the aperture of a door or window towards the inside wall to admit more light. An aperture in the wall for pointing cannon through.

Encarpus.—A festoon of fruit or flowers, which sometimes ornaments friezes or capitals.

Engaged columns, are those attached to or built in walls or piers, a portion being concealed.

English Architecture.—A name sometimes given to the Gothic style.

Ensemble.—Means the whole work or composition considered together, and not in parts.

Entablature.—That assemblage of mouldings, etc., which are supported by a column. It consists of three parts, the cornice, frieze and architrave.

Entail.—In Gothic architecture, delicate carving.

Entasis.—The slight swelling or graceful curvature of Grecian columns, particularly the Doric.

Enripus.—The trench in a circus which separates the seats from the arena.

Eustyle.—An intercolumniation of two diameters and a quarter, which is one of the most beautiful arrangements that can be given in a row of columns.

Extrados.—The outside of an arch or bridge, vault, etc.

Eye.—The middle of the Ionic volute, from which the different centres for drawing it are found; also, a small window in the centre of the pediment.

Fabric.—A large building, as a church, palace or college.

Facade, or Face.—The whole exterior side of a building that can be seen at one view; strictly speaking, the principal front.

Face Mould.—The pattern for marking the plank or board out

of which ornamental hand railings for stairs and other works are cut.

Face of a Stone.—The smooth or outward part of a building; stones should be faced the opposite direction of their splitting.

False Attic.—Bears some resemblance to the Attic order but without pilasters, casements, or balustrade, used to crown a building, and to bear a bas relief or inscription.

False Roofs.—The space between the highest ceiling and the roof.

Fanal.—A light-house.

Fane or Vane.—A plate of metal cut into some fantastic shape and turning on a pivot to point out the course of the wind.

Fan-Tracery.—The very complicated mode of roofing used in the perpendicular style in which the vault is covered by ribs and veins of tracery.

Fascia.—A flat broad member in the entablature of columns or other parts of buildings but of small projection. The architraves in some of the orders, are composed of three bands or fascia; the Tuscan and the Doric ought to have only one.—Ornamental projections from the walls of brick buildings over any of the windows, except the uppermost are called *fascia.*

Feather-edged Boards, are narrow boards made thin at one edge, like shingles or some kinds of clapboarding.

Femur.—The plane space between the cavities of a triglyph.

Festoon.—An ornamental carving resembling a wreath, attached at both ends and falling in the middle.

Fillet.—*See Annulet and Band.*

Filling in Pieces, are short pieces of timber affixed to hips and roofs of groins.

Fishing.—A built beam composed of two beams placed end to end, secured by pieces of wood covering the joint on opposite sides.

Fistuca.—A pile-driving instrument with two handles, raised by pulleys and guided in its descent to fall on piles.

Flags, are flat stones, from 1 to 3 inches thick for floors.

Flank.—The least side of a pavilion by which it is joined to the main building.

Flatting.—Painting finished without leaving a gloss on the surface.

Flashings.—Pieces of lead so let into the wall as to lay over a gutter.

Floating, is the equal spreading of plaster or stucco on the surface of walls.

Floriated.—*Gothic.* Having florid ornaments as in Gothic pillars.

Florid Style.—*See Gothic.*

Flush.—The continuity of two or more parts of work to the same surface.

Flue.—The tube from a fire-place.

Fluting.—Longitudinal cavities or channels cut in the shaft of a column or pilaster, etc., sometimes meeting one another at a sharp edge, at other times having a fillet between them.

Flyers, are steps in a series, which are parallel to each other.

Foliage.—An ornamental distribution of leaves on various parts of buildings.

Foliation.—The use of small arcs or foils in forming tracery.

Foils.—The small arcs in the tracery of Gothic windows, panels, etc.

Font.—A vessel in churches generally of marble to contain the water of baptism.

Footing Beam.—The name sometimes given to the tie beam of a roof.

Footing, of a wall; a projecting course of stone at the base of a wall or building, intended to give stability and support.

Foot-Pace.—A flat part in a stairs, or hand-railing, between the step and the landing place.

Foundation.—That part of a building or wall which is below the surface of the ground.

Four-leaved-flower.—An ornamental member much used in hollow mouldings.

Founerets.—The arches which in Gothic groins lie next the wall.

Fox-Tail wedging, is a peculiar mode of mortising, in which the end of the tenon is notched beyond the mortise and is split, and a wedge inserted which being forcibly driven in, enlarges the tenon and renders the joint firm and immovable.

Frame.—The name given to the woodwork of windows, doors, etc.; and in carpentry, to the timber works, supporting floors, roofs, etc.

Fresco.—The most ancient way of ornamenting houses by painting on stucco whilst that substance is soft and fresh; very suitable for splendid edifices, etc.

Fret.—A kind of ornamental work which presents a rough or uneven appearance.

Frieze.—The flat member in an entablature, separating the architrave from the cornice.

Frieze-Panel.—The upper panel of a door of six panels.

Frieze-rail.—The rail next to the top rail of a door of six panels.

Frigidarium.—An apartment in the Roman bath, supplied with cold water.

Frigiratory.—Generally an underground apartment well ventilated and fitted up for preserving animal and vegetable food.

Frontispiece.—An ornamented front of a building.

Frosted.—A kind of ornamental work, having an appearance like that of hoar frost.

Funnel.—The inside of a shaft of a chimney.

Furniture.—The name given the fastenings of doors, windows and other similar parts of a house.

Furrings.—Flat pieces of timber used to bring an irregular framing to an even surface.

Fusurole.—A small member in form of a collar, with long heads under the echinus, or quarter-round of pillars of the Doric, Ionic and Composite orders.

Fut, or Fust.—The shaft of a column.

Gain.—The leveled shoulder of a binding joist.

Garland.—Ornament, of flowers, fruits, etc., frequently used on triumphal arches and feasts by the ancients, and on tombs by the moderns.

Gathering of the Wings.—That part of a chimney which connects the breast with the flue.

Geometrical Stair.—A flight of stairs, supported only by the wall at one end of the steps.

Geometrical Elevation.—A drawing of the front or side of a building, the projection of a vertical plane of the front or side of a building or other object.

Geranos.—A machine used behind the screens at Greek theatres, by means of which the actors might be raised into the air.

Girder.—The largest piece of timber in a floor, that into which the joists are framed, used to shorten the joists of a floor.

Girdle.—The circular band round a column.

Glyph.—An ornamental cavity or incision.

Goddroon.—A kind of inverted fluting.

Gorgoneid.—Key stones carved in the form of Gorgon's heads.

Granary.—To preserve grain, etc.

Grange.—A barn usually attached to abbeys.

Graticulation.—Dividing a drawing into squares in order to reduce it to smaller dimensions.

Græcostasis.—A hall or portico in which ambassadors to Rome awaited the deliberations of the senate.

Grillage.—A frame work of beams laid longitudinally and crossed by similar beams notched upon them, used to sustain walls to prevent irregular settling.

Groin.—The angular curve made by the intersection of two semicircles or arches.

Groined Ceiling.—A surface formed by three or more curved surfaces, so that every two may form a groin, all the groins terminating at one extremity in a common point.

Grotesque.—A singular and fantastic style of ornament found in ancient buildings.

Grotto.—An artificial cavern.

Ground-joists, are joists supporting the floor immediately above the ground.

Ground floor.—The lowest story of a building.

Ground Niche.—A niche rising from the floor.

Ground Plan.—A drawing of the foundation of a building.

Ground Plates.—The outermost pieces of timber lying on the ground into which joists, girders, etc., etc., are mortised.

Grounds.—Pieces of wood imbedded in the plastering of walls to which skirting and other joiners's work are attached.

Grouped Columns, are when three, four, or more columns are put together on the same pedestal. When two are placed together, they are said to be coupled.

Grout.—A thin kind of mortar.

Guerite.—A small tower on the point of a bastion, for the use of a sentinel.

Guillochi.—Ornaments in the form of a series of spiral strings.

Guttæ.—Ornaments of a conic form, on the cornice of the Doric order; they are supposed to represent drops of water.

Gymnasium.—A building classed in the first rank by the Greeks; it was in them they instructed the youth in all arts of peace and war—a building for athletic exercises.

Hocking.—An inferior mode of walling to save stones.

Half-space, or resting place.—The interval between two flights of steps in a staircase.

Halving.—The junction of two pieces of timber, by inserting one into the other.

Hammer Beam.—A beam in a Gothic roof, not extending to the opposite side. A beam at the foot of a rafter.

Hangings.—Tapestry; originally invented to hide the coarseness of the walls of a chamber, different materials were employed for this purpose, some of them exceedingly costly and beautifully worked in figures, gold and silk.

Hanging Buttress.—A buttress not rising from the ground but supported on a corbel, applied chiefly as a decoration and used only in the Decorated and Perpendicular style.

Hanging Style, of a door is that to which the hinges are fixed.

Handspike.—A lever for carrying a heavy beam.

Haunches, of an arch.

Headers.—*In Masonry,* are stones or bricks extending over the thickness of a wall.

Heading Courses.—Courses of a wall in which the stone or brick are all *headers.*

Head-way, *of a stair,* is the clear distance measured from a given landing place or stair to the ceiling, allowing for the thickness of the steps.

Headwork.—A name given to ornaments on key stones of arches, frequently representing the heads of animals appropriate to the purpose for which the building was erected.

Heart-Bond.—*In Masonry,* is where two stones, forming the breadth of the wall, have one stone of the same breadth placed over them.

Heel, of a *Rafter.*—The end or foot that rests upon the wall plate.

Height, of an *Arch.*—A line drawn from the middle of the chord to the intrados.

Helix.—A small volute or twist like a stalk, representing the twisted tops of the acanthus, placed under the abacus of the Corinthian capital.

Hem.—The spiral projecting part of the Ionic capital.

Hick-Joint Pointing.—Inserting a superior mortar between joints of ashlar, and made correctly smooth with the surface.

Hindu Architecture.—In style and construction, has a great resemblance to Egyptian, and is akin to that of the people that formed the vast excavations of Ellora, Elephanta, and Canarah, and the various immense pagodas and colossal images of the Indian idols.

Hips.—Those pieces of timber placed in an inclined position at the corners or angles of a roof.

Hip-Roof.—A roof which rises by equally inclined planes rising from each other.

Hippodrome.—A place appropriated by the ancients to equestrian exercises.

Hoarding.—The timber enclosure about a building when it is erecting.

Horizontal Cornice is the level part of the cornice of a pediment, under the two inclined cornices.

Horn.—A name sometimes given to the Ionic volute.

Hovelling.—A mode of preventing chimneys from smoking, by carrying up the two most exposed sides higher than the others; apertures are left in the sides for the escape of smoke below.

Hypocaustum.—An arched chamber among the ancients in which a fire was made to warm the rooms above.

Ichnography.—The transverse section of a building which represents the circumference of the whole edifice, the different rooms and apartments, with the thickness of the walls, the dimensions and situation of the door, windows, chimneys, the projection of the columns, and everything that could be seen in such a section.

Imbow.—To arch over.

Impetus.—The span of a building, arch, roof, etc.

Impluvium.—The central part of an ancient Roman court, which was uncovered.

Impost.—The combination of mouldings which form the capital of a pier; the layer of stone which crowns the doorpost or pier, and which supports an arcade, etc.—it generally projects, and is ornamented with mouldings. An arched impost is that which crowns the pier of an arcade, or which crowns a circular wall, niche, etc.

In Antis.—When there are two columns between the antæ of the lateral walls and the cella.

Inbond Jambstone.—A bond stone laid on the joint of an aperture.

Insertum.—A mode of building, which consists of small rough stones and mortar.

Inclined Plane.—One of the mechanical powers.

Incrustation.—Anything such as Mosaic, scagliola, etc., applied with mortar or with mastic to incisions that have been made for its reception.

Indented.—Toothed together.

Inlaying.—See Mosaic.

Intaglio.—A sculpture or carving in which the figures are sunk *below* the general surface, such as a seal, the impression of which in wax is in bas-relief; opposed to *Cameo.*

Interlacing Arches.—Circular arches which intersect each other.

Intercolumniation.—The space between two columns measured from the place where they are of an equal thickness. Generally from the lower part of the shaft immediately above the base.

Interties are short pieces of timber used in roofing, to bind upright posts together in roof partitions, in lath and plaster work, and in walls with timber frame work.

Intrados.—The interior or under concave curve of an arch. The exterior is called *extrados.*

Inverted Arches.—Such as have their intrados below the centre or axis. They are a great utility in giving stability to buildings in all cases where the wall is higher on each side than the cord of the arch.

Iron Chains, under the roofs of circular buildings, are found of great utility in preventing the pressure of the incumbent weight from pushing out the walls, especially in domes of great magnitude. The dome of St. Paul's has two, which are sunk into the circular course of stone.

Italian Architecture.—It comprehends the Florentine, Roman and Venetian.

Jack Arch.—An arch of only the thickness of one brick.

Jack-Rafters.—The jack-timbers which are fastened to the high rafters and the wall plates.

Jack Ribs.—The jack timbers or parts of curved ribs which are fastened to the angle ribs, and rest upon the wall plates, in groining or domed ceilings.

Jack Timber.—A short timber fastened at the ends to two timbers which are not parallel, or to two timbers which actually meet in a point, or to the wall plate, and hip rafter of a roof, etc.

Jambs.—Door posts or upright posts at the ends of window-frames; also, the upright sides of a fire place.

Jamb-Lining.—The side-work of doorways.

Jamb Posts.—Uprights on the sides of doorways, on which the jamb-linings are fixed.

Jerkin-Head.—A roof on which the gable is carried higher than the side walls.

Joggle-Post.—A strut-post for fixing the lower ends of the struts.

Joinery.—That branch in building confined to the nicer and more ornamental parts of carpentry.

Joggles.—Joints in stone to prevent them from sliding past each other.

Jube.—The rood loft or gallery into the choir.

Keep.—The strongest part of the old English castles, forming the citadel of the fortress.

Kerf.—A slit or cut in a piece of timber or in a stone, usually applied to that made by a saw or axe.

Keys.—In naked flooring are pieces of timber fixed in between the joists by mortise and tenon; when these are fastened with their ends projecting against sides, they are termed strutting pieces.

Keys.—Pieces inserted in boards to prevent warping.

Key Stone.—The stone placed in the centre of the top of an arch. The character of the key stone varies in different orders. In the Tuscan and Doric it is only a simple stone projecting beyond the rest; in the Ionic it is adorned with mouldings in the manner of a console; in the Corinthian and Composite it is a rich sculptured console.

Knee.—A part of the back of a handrailing of a convex form, the

reverse of a *ramp*, which is a back of a handrail and is concave; also, any piece of timber bent to an angular joint.

Label.—*Gothic.* The drip or wood-moulding of an arch, when it is returned to the square.

Labyrinth.—A building full of numerous and intricate passages.

Lacunæ.—Panels or coffers in ceilings, or in soffits or cornices; the flat roof of a room.

Laconicum.—One of the apartments of the ancient baths.

Lady Chapel.—A small chapel dedicated to the Virgin Mary, generally found in ancient cathedrals.

Lancet.—*Gothic.* Pointed.

Landing.—The terminating of a stairs, or a broad step where the entrance to a room occurs in the course of a staircase.

Lantern.—*Gothic.* A turret placed above a building and pierced with windows.

Lararium.—A kind of domestic chapel in a Roman house, dedicated to the worship of his household gods.

Lattice.—A reticulated window, made of laths or slips of iron, separated by glass windows, and only used where air rather than light is to be admitted, as in cellars and dairies.

Laura.—A collection of little cells, or monkish habitations, contiguous to each other, in which hermits in ancient times lived together in a wilderness.

Lazaretto.—In Italy, a hospital for the reception of persons sick of contagious disorders.

Lean-to.—A small building whose side-walls and roof project from the wall of the larger building.

Lectern.—The reading desk in the choir of churches.

Ledge, or Ledgement.—A projection from a plane, as slips on the sides of window and door frames to keep them steady in their places.

Ledgers.—The horizontal pieces fastened to the standard poles or timbers of scaffolding raised around buildings during their erection. Those which rest on the ledgers are called *putlogs*, and on these the boards are laid.

Lewis.—An instrument of iron used for raising large stones.

Lining.—Covering for the interior, as casing is covering the exterior surface of a building; also such as linings *of a door* for windows, shutters, and similar work.

Lintel.—The horizontal piece which covers the opening of a door or window.

List.—A little square moulding, to crown a larger, also termed a fillet.

Lobby.—An open space surrounding a range of chambers, or seats in a theatre; a small hall or waiting room.

Lodge.—A small house in a park.

Lombard Architecture.—A name given to round-arched architecture of Italy, introduced by the conquering Goths and Astrogoths, and which superseded the Romanesque. It reigned between the eighth and twelfth centuries.

Loop.—A small narrow window.

Lorimer.—A square member under, or forming part of a cornice, which projects and has a groove in its under side.

Lotus.—A plant of great celebrity amongst the ancients, the leaves and blossoms of which generally form the capitals of Egyptian columns.

Louvre.—A kind of vertical window, frequently at the top of roofs, and provided with horizontal slats, which permit ventilation and exclude rain.

Luffer-boarding.—Boards nailed on the sides of buildings or lanterns, or across apertures, so as to admit air but exclude rain.

Lunette.—Spherical apertures in ceilings.

Lying panels.—Those which are cut out with the grain of the wood in a horizontal direction.

Mansard Roof.—*Curb Roof,*

Marquetry.—Inlaid work of fine hard pieces of wood of different colors, fastened to the leaves on a ground. *See Parquetry.*

Masonry.—Stone work.

Mauresque.—The style of building peculiar to the Moors and Arabs.

Mausoleum.—A sumptuous sepulchral monument.

Meandar.—An ornament composed of two or more fillet mouldings, intertwined in various ways.

Medallion.—Any circular tablet on which are embossed figures or busts.

Medianos.—The middle columns in a portico where the intercolumniation is enlarged.

Mediæval Architecture.—The architecture of England, France, Germany, etc., during the middle ages, including Norman and early Gothic style. It comprises also the Romanesque, Byzantine and Saracenic, Lombard and other styles.

Members.—The different parts of a building, the different parts of an entablature, the different mouldings of a cornice, etc.

Meros.—A triglyph consists of six parts, two and a half of which are on each side, and the meros is in the centre and constitutes one part.

Metoche.—The intervals between two denticuli in the Ionic entablature.

Metope.—The interval between the triglyphs in the Doric order.

Mezzo-relievo.—Or mean relief, in comparison with alto-relievo or high relievo.

Minaret.—*Turkish.* A circular turret rising by different stages or divisions, each of which has a balcony.

Minute.—The sixtieth part of the lower diameter of a column; it is the measure used by architects to determine the proportions of an order.

Minster.—A monastery, a cathedral church.

Modillion.—A projection under the corona of the richer orders, resembling a bracket. The Grecian Ionic has no modillion, the Roman but seldom. The ornament is principally used in the Corinthian and Composite order.

Modillion.—An enriched bracket used under the corona of the Corinthian and Composite entablatures.

Module.—The semi-diameter of a column, equal to 30 minutes, the measure by which architects determine the proportions of an order.

Monkey.—A name given to a block of iron with a catch used in gins for driving piles.

Monotriglyph.—The space of one triglyph and two metopes, between two Doric columns.

Mosaic.—A term applied to pavements, and other work when formed of various materials of different shapes and colors, laid on a kind of stucco so as to present some pattern or device. The materials used by the ancients were composed of small cubes of glass, stone, wood, etc.

Mosque.—A Mahometan temple, or place of worship.

Mouldings.—Ornaments.

Mullions.—*Gothic.* The frame work of a window with upright bars to divide the lights.

Multilateral.—Having many sides.

Mutule.—A projecting ornament of the Doric cornice which occupies the place of the modillion in the other order and supposed to represent the ends of rafters.

Naked.—This term is applied, in architecture, to a plain surface, or that which is unfinished; as the naked walls, the naked flooring, that is, uncovered; the word is sometimes applied to flat surfaces before the mouldings and other ornaments have been fixed.

Nattes.—A name given to an ornament for decorating surfaces, used in the twelfth century from its resemblance to interlaced withes of matting.

Natural beds.—In stratified rocks is the surface of a stone as it lies in the quarry. If not laid in walls in their natural bed the laminæ separate.

Nave.—The middle part of the church.

Neck.—The space between the camelures and annulets of the Doric capital, in Grecian examples; and in Roman that between the astragal and annulet. It is seldom found in the Ionic.

Neck-mould.—*In Gothic architecture.* The moulding which separates the capital from the shaft, or that under the finial of a pinnacle or canopy.

Nerves.—The mouldings of the ribs of Gothic groins.

Newel.—The upright cylinder or pillar, around which winding stairs turn.

Niche.—A cavity or hollow in a wall for the reception of a statue, etc. Niches are seldom found in pure Grecian buildings, and in Roman they are generally ornamented, but in the Gothic they are highly enriched—niches are made to partake of all the segments under a semi-circle.

Norman architecture.—A style imported into England by the Normans at the time of the conquest and used until the end of the twelfth century, when it was superseded by painted or Gothic.

Nosings.—The rounded and projecting edges of the treads of a stair.

Notch-Board.—A board which is grooved or notched for the reception and support of the ends of a staircase.

Nymphæum.—A name given by the ancients to picturesque grottoes and woody places.

Obelisk.—Lofty pillars of stone, of a rectangular form diminishing towards the top and generally ornamented with inscriptions and hieroglyphics amongst the ancient Egyptians.

Observatory.—A building erected on an elevated spot of ground for making astronomical observations.

Octostyle.—A temple with eight columns on its principal façade.

Odeum or Odeon.—A species of theatre among the Greeks in which the poets and musicians submitted their works to the approval of the public.

Offsets.—When the face of a wall is not one continued surface, but formed of one or more continued surfaces each rising from the horizontal base, the part connecting the two is called an offset.

Ogee.—A moulding the same as the cyma reversa.

Ogive.—*Gothic.* An arch or branch of a vault, which instead of being circular, passes diagonally from one angle to another, forming a cross with the other arches. The centre where the ogives cross is called the key, and is cut in the form of a rose. The mem-

bers or mouldings of the ogives are called nerves, branches or reins, and the arches which separate them, double arches.

Oratory.—A closet for private devotion in Roman Catholic families with altar and crucifix.

Orchestra.—*In ancient theatres*, where the chorus used to dance; in modern theatres where the musicians sit.

Order.—The five orders of architecture as transmitted from antiquity are, the *Doric*, the *Ionic*, the *Corinthian*, the *Tuscan* and the *Composite*.

Oriel Window.—*Gothic.* A projecting angular window commonly of a triagonal or pentagonal form, and divided by mullions and transoms into different bays and compartments.

Orle.—A band or fillet under the ovolo of the capital.

Out and In Bond.—An alternate header and stretcher in quoins and window and door jambs.

Ova.—An ornament in the form of an egg.

Ovolo.—*See Echinus.*

Pagoda.—A name given to temples in India and China.

Painting.—*See Fresco.*

Palace.—The dwelling of a King, Prince, or Bishop.

Palæstra.—The part in a Grecian Gymnasium, appropriated to wrestling.

Palisades.—Stakes set up for an enclosure.

Pallification, or Piling.—The art of piling ground-work or strengthening it with piles.

Pampre.—An ornament composed of vine leaves and bunches of grapes, with which the hollow of the circumvolutions of twisted columns are sometimes decorated.

Pancarpi.—Garlands and festoons of fruit, flowers and leaves, adorning altars, doors, vestibules, etc.

Panel.—A thin board having all its edges inserted in the groove of a rounding frame; in masonry one of the faces of a hewn stone.

Parapet.—A low wall of masonry or earth for support or railing to a quay, bridge, terrace, etc.

Pargetting.—Rough plastering, commonly adopted for the interior surface of chimneys.

Parquetry or Marquetry.—A kind of inlaid floor composed of small pieces of wood either square or triangular which are capable of forming, by their disposition, various combinations of figures; this description of joinery is very suitable for the floors of libraries, halls and public apartments.

Party-walls.—Partitions of brick between buildings in several occupations.

Parvis.—Formerly a room over the church porch; where schools used to be held.

Patera.—A vessel used in the Roman sacrifices.

Paternosters.—Rows of beads carved on mouldings.

Pavement.—*Tessellated*, a pavement of mosaic work, used by the ancients, made of square pieces of stone, etc., called *Tessera.*

Pavilion.—A turret or small insulated building, and comprised beneath a single roof; also the projecting part in front of a building which marks the centre, and which sometimes flanks a corner, when it is termed an *angular pavilion.*

Pedestal.—The square support of a column, statue, etc.; and the base or lower part of an order of columns: it consists of a plinth for a base; the die; and a talon crowned for a cornice. When the height and width are equal, it is termed a square pedestal; one which supports two columns, a double pedestal; and if it supports a row of columns without any break, it is a *continued pedestal.* The lowest and most simple kind of pedestal is the Tuscan, which is about three modules in height by one authority, and five by another.

Pedicular.—*In the middle ages*, a kind of prison in which the feet were bound in chains.

Pediment.—A low triangular crowning ornamented in front of a building, and over doors and windows. Pediments are sometimes made in the form of a segment; the space enclosed within the triangle is called the tympanum.

Pend.—*Gothic.* A vaulted roof without groining.

Pendant.—*Gothic.* A hanging ornament in very rich Gothic groined roof.

Pendent Bridge.—A wooden bridge with butments only at the ends, and supported by pillars.

Pendative.—The whole body of a vault, suspended out of the perpendicular of the walls.

Pendative Bracketing, or Cove Bracketing, springing from the rectangular walls of an apartment upwards to the ceiling, and forming the horizontal part of the ceiling into a circle or ellipse.

Pendative Cradling.—The timber work for sustaining the lath and plaster in vaulted ceilings.

Penetrale.—The most sacred part of heathen temples.

Penetralia.—Small chapels in the innermost part of the Roman houses, dedicated to the *penates* or household gods, and in which they deposited whatever was held most valuable.

Penitentiaries.—*Amongst the Monks*, were small square houses in which the penitent shut himself up.

Pentastyle.—Having five columns in front.

Perclose.—*Gothic.* A closet.

Periæti.—The revolving scenes of Roman Theatre.

Peribolos.—A court or enclosure within a wall, sometimes enclosing a Grecian temple.

Peristyle.—A range of columns within a court or building.

Perpendicular style.—The third and last of the pointed or Gothic styles, also called the *Florid* style.

Perpent stone.—A long stone, intended to reach through a wall, so as to be visible on both sides and therefore wrought and smooth at the ends.

Perron.—A staircase lying open, or outside the building; more properly the steps in front of a building which lead to the first story.

Persian Architecture was very imperfect, though the style in massiveness of proportions, absence of arches and pyramidal inclination of many of the buildings bears a great resemblance to the Egyptians and Indians.

Perticæ.—Beams in the ancient churches, behind and about the altar, and ornamented at feasts with reliquaries.

Pharos.—Amongst the ancients, a light house.

Piazza.—A continued arch-way, or vaulting, supported by pillars; a portico.

Picturesque.—*In Architecture.* The agreement of the style of the building with the situation in which it is to be placed.

Piedouche.—A small square base, smoothed and wrought with mouldings, which serves to support a bust, or statue, drawn half-way, or any small figure in relief.

Piedroit.—A square pier, partly hid in the wall; differing from a pilaster in having no regular base.

Pier.—A mass of stone, etc., opposed to the face of the sea; a square or other formed mass of masonry or brick used to strengthen or support a building. The supports between the arches of a bridge from which they spring are sometimes called a pier. The term is also usually employed to designate the doors or windows of a building.

Pile.—A term given to buttresses built against the walls of a house.

Pilaster.—A kind of square column insulated or engaged to the wall, which has its proportions and ornaments, such as flutings, etc., like those columns of the order from which it is named. The pilaster owes its origin to the necessity of giving more solidity to the walls of temples where it was first used under the name of entæ.

Pilaster.—Masses. *In Gothic architecture,* rectangular pillars or portions of walls with impost mouldings.

Piles.—Large timbers, usually shod with iron, and driven into the ground for the purpose of making a sure foundation.

Pillar.—An irregular and rude column. The supports in Saxon, Norman and Gothic architecture are pillars, not columns, the form and dimensions are guided by no rules; they generally have a kind of fort or base and a sort of cornice above, but are sometimes without either. In common language pillar and column are often used as synonymous. Pillars are sometimes isolated. It differs from a column in having no architectual proportion, being either too massive or too slender.

Pinnacle.—A small spire used to ornament Gothic buildings.

Pit.—The part of a theatre between the galleries and the stage.

Pitch of a Roof.—The proportion obtained by dividing the span by the height, thus we speak of its being one-half, one-third, one fourth. When the length of the rafters are equal to the breadth of the building it is denominated Gothic.

Place.—An open piece of ground surrounded by buildings, generally decorated with a statue, column or other ornament.

Pitching-piece.—A horizontal timber, with one of its ends wedged into the wall at the top of a flight of stairs, to support the upper end of the rough strings.

Pix.—A box or shrine, intended to contain the host or consecrated wafer suspended under the canopy of the altar, used in the middle ages.

Plafond.—The ceiling of a room, a soffit.

Plan.—The draught of a building taken on the ground floor, showing the distribution, form and extent of its several rooms, passages, etc. *In plans of buildings*, the massive parts, as walls, etc., are generally distinguished by a dark shade, or shade of tints approaching the color of brick or stone. In a *geometrical plan,* the parts are represented in their natural proportions. *The raised plan* of a building is the elevation.

Plancere.—The underpart of the roof of a corona, which is the superior part of the cornice between two cymatia.

Platband.—Any square moulding with little projection; the fascia of an architrave; the list between the flutings, etc.

Platband, the of a door or window, is the lintel when it is made square and not much arched.

Platform.—A row of beams which support the timber work of a roof, lying at the top of a wall; a terrace, or open walk on the top of a building.

Plinth.—The solid support or base of a column, or pedestal. In a wall, the term *plinth* is applied to two or three rows of bricks which project from it to any flat moulding in a front wall, to make the floors sustain the eaves, or the larmier of a chimney.

Plug and Feather.—A mode of dividing large stone by means of a large tapering wedge, or key, and wedge-shaped pieces of iron, called feathers, driven into holes, previously drilled, into the rock to forcibly split it.

Piscina.—A niche in the south side of the altar in Roman Catholic churches containing a small basin and water drain, through which the Priest emptied the water in which he had washed his hands.

Podium.—A continued pedestal; a projection from a wall, forming a kind of gallery.

Polystyle.—A building with an indefinite number of columns.

Pole-plate.—A horizontal timber resting on the ends of the beams of roofs, and for supporting the feet of the common jack rafters, when such are used.

Poppy Head.—*Gothic.* An ornament carved on the raised ends of seats, benches, and pews in churches.

Porch.—An arched vestibule at the entrance of a church, or other building; the term is now applied to all kinds of vestibules.

Portal.—The arch over a door or gate; the frame work of a gate; the lesser gate, when there are two.

Portico.—A kind of covered gallery or piazza, erected in front of large buildings. It is composed either of vaults supported by arcades, or flat roofs supported by pillars, the sides being quite open.

Post.—Square timber set on end. The term is especially applied to those which support the corners of a building, and are framed into bressummers or crossbeams under the walls.

Posticum.—The porch in the back front of ancient temple.

Postique.—An ornament, etc., added after the rest of the work is done.

Powderings.—Devices to fill up vacant spaces in carved works.

Prætorium.—A name given to any building where causes were judged by a Roman Prætor; also to patrician's seats; there were also *Prætorian camps.*

Preceptories.—Names of estates of the Knight Templars on which they erected churches and houses for themselves and their fraternity.

Priming.—The laying on of the first shade of color.

Principal Brace.—A brace under the principal rafters.

Principal Rafters.—The two inclined timbers which support the roof.

Presbytery.—The part of a church appropriated to officiating priests, comprising the choir, and other eastern portions of the edifice.

Priory.—A building of the same nature as a monastery, or an abbey, whose governor was denominated a prior.

Profile.—The outline; the contour of a part, or the parts compassing an order, as of a base, cornice, etc.; also the perpendicular section. It is in the just proportion of their profiles that the chief beauties of the different orders of architecture depend. The ancients were most careful of the profiles of their mouldings.

Projecture.—The prominence of the mouldings and members beyond the naked surface of a column, wall, etc.

Propylon.—A vestibule.

Proscenium.—The front part of the stage of ancient theatres on which the actors performed.

Prostas.—In Grecian houses, the passage which separated the bed chamber from the ante-chamber.

Prostyle.—Temples with columns only in front.

Prothyrum.—A porch at the outer door of a house; a rail to defend the door from horses, carts, etc.

Pugging.—A coarse kind of mortar laid on the boarding, between joists.

Pulley Mortise.—A long mortise, parallel to the under side of the bonding joists, for the reception of the ceiling joists.

Purfled.—Ornamented with carving, resembling embroidery, lace-work, fringes or flowers—an old term.

Purlins.—Those pieces of timbers which lie across the rafters to prevent them from sinking.

Put-log.—Horizontal pieces for supporting the floor of a scaffold, one end being inserted into put-log holes, left for that purpose in the masonry.

Puzzolanna.—A greyish earth used for building under water.

Pyramid.—A solid, having one of its sides, called a *base*, a plain figure, and the other sides triangles, these points joining in one point at the top called the vertex. Pyramids are called triangular, square, etc., according to the form of their bases.

Quarry.—A pane of glass cut in a diamond, or lozenge form.

Quarters.—Slender pieces of timber placed between the puncheons of the posts to nail the laths in partitions.

Quatrefoil.—*Gothic.* Small panel, formed by cusps or foliations, into four leaves, used in early English and decorated styles.

Quirk.—A piece taken out of any regular ground, flat or floor.

Quirk Mouldings.—The convex part of Grecian mouldings when they recede at the top, forming a re-entrant angle, with the surface which covers the mouldings.

Quoins.—Stones, or other materials, put in the corners of buildings to strengthen them.

Rafters.—The secondary timbers of a house which are let into the great beam.

Rails.—*In framing*, the horizontal are called rails, and the perpendicular, stiles. The term is also otherwise applied.

Raiser.—The upright board on the foreside of the steps of a flight of stairs.

Raking.—Mouldings whose arrises are inclined to the horizon.

Raking Courses.—Diagonal courses of brick, laid in the heart of a thick wall between the outside courses.

Ramp.—A concavity on the upper side of hand railings formed over risers, made by a sudden rise of the steps above.

Rampant.—A term applied to an arch whose abutments spring from an inclined plane.

Rebate.—A groove on the edges of a board.

Recess.—A depth of some inches in the thickness of a wall, as a niche, etc.

Refectory.—An eating room in convents and other religious communities.

Reglet.—A flat, narrow moulding, used to separate from each other, the parts or members of compartments and panels, to form frets, knots, etc.

Regrating.—Putting a new surface on an old cut stone.

Regula.—A band below the tœnia of the Doric epistylium.

Rejointing.—Filling up joints again of stones in old buildings.

Relievo, or Relief.—The projecture of an architectural ornament. *See Basso Relievo.*

Rendering.—*Same as pargeting.*

Reredos, or Reredosse.—A screen or division wall placed behind an altar, rood-loft, etc., in old churches.

Reservoir.—An artificial pond or basin to collect water from mills, canals, etc.

Reticulatum.—A kind of masonry among the Romans in which the stones were laid diagonally.

Return.—The continuation of a moulding, projection, etc., in an opposite direction.

Return Head.—One that appears both on the face and edge of a work.

Revels, or Reveal.—The two vertical sides of an aperture, between the front of a wall and the window or door frame.

Rhodiacum.—The interior of an ancient Grecian house, occupied by the male part of the family.

Rib.—An arched piece of timber, sustaining the plaster work of a vault, etc.

Ribbet.—The recess in a wall to receive a door or window shutter as it folds back when opened.

Ridge.—The top of a roof which rises to an acute angle.

Ridge-pole.—The highest horizontal timber in a roof, extending from top to top of the several pair of rafters of the trusses, for supporting the heads of the jack rafters.

Riser.—The vertical board under the tread in stairs.

Rolls.—*Gothic.* Mouldings representing bent cylinders.

Rood-Loft.—A gallery between the nave and choir in churches, in front of which stood the rood (Saxon for a cross) and images of saints. In later times the rood lofts of English cathedrals have been occupied by organs.

Romanesque.—A general term for all those styles of architecture which, commencing with the Christian era, sprung from the Roman, and flourished until the introduction of the Gothic style. The styles are known in the various modifications by the names of Byzantium, Lombard, Saxon, etc. They are all in imitation of classical Roman architecture, altered and debased.

Rood-Tower.—The building at the interception of the nave and transept of a church, which covered the rood-loft, etc.

Rose, or Rosette.—An ornament sculptured in the centre of each face of the abacus of the Corinthian capital.

Rose-Window.—A circular window with compartments of mullions or tracery, branching from a centre; it is sometimes also called a catherine-wheel or marigold-wheel.

Rotunda.—A building which is round both within and without.

Rough-Casting is the throwing on a thin coat of plaster mixed with coarse sand or fine gravel over another.

Rudenture.—The figure of a rope or staff, which is frequently used to fill up the flutings of columns, the convexity of which contrasts with the concavity of the flutings, and serves to strengthen the edges. Sometimes, instead of a convex shape, the flutings are filled with a flat surface. Sometimes they are ornamentally carved, and sometimes on pilasters, etc. Rudentures are used in relief without flutings, as their use is to give greater solidity to the lower part of the shaft, and secure the edges. They are generally only used in columns which rise from the ground and are not to reach above one-third of the height of the shaft.

Rubble.—Masonry of rough, undressed stones. When only the roughest irregularities are knocked off, it is called *Scabbled rubble*, and when the stones in each course are rudely dressed to nearly a uniform height, *Ranged rubble.*

Rural Architecture.—That branch of architecture which relates to the construction of picturesque and rustic dwelling houses in the country.

Rustic or Rock Work.—A mode of building in imitation of nature. This term is applied to those courses of stone-work, the face of which is jagged or picked so as to present a rough surface. That work is also called rustic in which the horizontal and vertical channels are cut in the joinings of stones, so that when placed together, an angular channel is formed at each joint. *Frosted Rustic Work*, has the margins of the stones reduced to a plane parallel to the plane of the wall, the intermediate parts having an irregular surface. *Vermiculated Rustic Work*, has these intermediate parts so worked as to have the appearance of having been eaten by worms. *Rustic Chamfered Work*, in which the face of the stones being smoothed, and parallel to the face of the wall, and the angles bevelled to an angle of one hundred and thirty-five degrees with the face of the stone, when they come together on the wall, the bevelling will form an internal right angle.

Scabble.—To dress off the rougher projections of stones for rubble masonry with a stone axe or scabbling hammer.

Sacellum.—A small chapel among the Romans, without a roof, sacred to the gods. *In old church Architecture*, a small burial chapel.

Sacrarium.—A kind of family chapel in Roman houses, dedicated to one particular deity.

Saracenic Architecture.—That Eastern style employed by the Saracens, and which distributed itself over the world with the religion of Mahomet. It is a modification and combination of the various styles of the countries which they conquered.

Sacristy.—A strong room attached to a church, in which the sacred vestments and utensils are deposited.

Sagging.—The bending of a body in the middle by its own weight.

Saliant.—A projecture.

Saloon.—A lofty hall usually vaulted at the sides with two stages of windows. It is of various forms.

Sanctuary, or Asylum.—A place privileged by a sovereign; whence such offenders or debtors as fled to it for protection, could not forcibly be taken without sacrilege. Among the Jews the most sacred and retired place in the temple, called the *Holy of Holies*.

Sarcophagus.—A tomb or coffin made of stone.

Sash.—The frame work which holds the glass in a window.

Saxon Architecture.—Comprehends all English architecture previous to the Gothic style, which is characterized by round-headed doors and windows, and constructed between the conversion of the Saxons in 597, and the Norman conquest in 1066, with the exception of the short reigns of three Anglo-Danish kings.

Saxon Architecture.—The architecture which prevailed in England previous to the Norman conquest. The style was marked by extreme rudeness and simplicity.

Scamillus.—A small plinth below the bases of the Ionic and Corinthian columns.

Scantling.—The dimensions of a piece of timber in breadth and thickness; also, quarterings for a partition, when under five inches square, also applied to stone in a cubical form.

Scarfing.—The joining and bolting of two pieces of timber together transversely, so that the two appear as one.

Scenography.—The representation of solids in perspective.

Scotia.—A semi-circular concave moulding in the bases of Ionic columns. Also, the groove or channel cut in the projecting angle of the Doric corona.

Scratch Work.—A kind of fresco with a black ground, covered with a coat of white, which is afterward scratched with a pointed instrument, so that the black appears through the scratches.

Screeds.—Long narrow strips of plaster put on horizontally along a wall, and carefully faced out of wind, to serve as guides for plastering the wide intervals between them.

Screen.—Partitions generally wrought with rich tracery, etc., placed before small chapels and tombs, or behind the high altar. Also a rectangular frame with a wire bottom, for sifting sand, gravel, etc.

Scribing.—Fitting woodwork to an irregular surface.

Scribe.—To trim off the edge of a board, etc., so as to make it fit close to an irregular surface.

Scroll.—See Volute.

Scutcheon.—A shield for armorial bearings.

Section.—In architectural drawings, a view of an edifice, as cut down the middle, showing the disposition of the interior.

Sedilia.—Recessed niches three in number, for the use of the priest, deacon, and sub-deacon during part of the service of high mass.

Sesspool or Cesspool.—A well sunk under the mouth of a drain to receive the sediments which might choke its passage.

Set off.—A sloping face of masonry, marking the divisions of a buttress.

Setting.—In masonry, fixing stones in walls.

Shaft.—The body of a column; that cylindrical part between the base and the capital.

Shaft.—In a chimney is the stone or brick turret above the roof.

Shank.—The space between the channels of the Doric triglyph, which is sometimes turned the *leg of the triglyph.*

Shore.—A piece of timber placed in an oblique direction to support a building or wall.

Shoe.—The part at the bottom of a leaden pipe, or water trunk which is intended to turn the course of the water.

Shrine.—The tomb of a saint. The altar is sometimes called the shrine.

Sill.—The timber or stone at the foot of a door etc.

Ground sills.—Are the timbers on the ground which support the posts and superstructure of a timber building. The term is most frequently applied to those pieces of timber or stone at the bottom of doors or windows.

Siparium.—A curtain which was often employed instead of a door to separate one room from another; also to conceal the images of the deity when sacrifice was not performing.

Skewback.—The inclined stone from which an arch springs.

Skirtings.—The narrow boards which form a plinth round the margin of a floor.

Skew.—*Corbel.* A stone built into the bottom of a gable to form an abutment for the coping.

Sleepers.—Timbers laid upon dwarfwalls, for supporting the ground joists of floor; cross timber for fixing the flanking where it is necessary to pile under to make a foundation.

Soffit.—The under part or ceiling of a cornice; the panneling over head, such as the underside of tops of windows; the ceiling of an arch.

Sound Boarding.—Short board placed between joists, for pugging or any other substance for preventing the transmission of sound.

Sounding Board.—A concave sound board of pine-wood, having the form resulting from half a revolution of one branch of a parabola on its axis, its axis should be inclined forward to the plane of the floor, at an angle of about ten or fifteen degrees, it should be elevated so that the speaker's mouth may be in the focus; a small curvilinear piece may be removed on each side from beneath, so that the view of the preacher from the side galleries may not be intercepted. This description of sounding board has been found to completely remedy defective acoustic properties in churches where it has been tested.

Spandril.—The angle formed by a stairway.

Spherical Bracketing.—Brackets of such a form that the surface of lath and plaster will form a spherical surface.

Spiral.—A curve line of a circular kind which in its progress recedes from its centre.

Spire.—A steeple diminishing as it ascends.

Splayed.—The jamb of a door or anything else of which one side makes an oblique angle with the other.

Springing.—Setting the boards of a boarded roof together with bevel joints.

Springing course.—The horizontal course of stones whence an arch rises.

Stadium.—Among the Greeks, the open space where the athletæ exercised in running and contested for the prize; also a Greek measure containing 125 paces.

Stalk.—A kind of ornament in the Corinthian capital, which is sometimes fluted, and resembles a stalk, and from which springs the volute and helices.

Stall.—An elevated seat in the choir or chancel of a church, appropriated to an ecclesiastic, as the prebendal stalls in a cathedral.

Stanchion.—A prop or support, the perpendicular mullions or upright bars of a window or open screen.

Steeple.—An appendage generally erected at the west end of a church, to contain the bells, and rising either in form of a tower or of a spire.

Stereobate.—The basis or foundation from which a wall, column or building rises.

Stiles.—The vertical parts of a frame.

Stilts.—Piles driven into the ground to support the piers of a bridge.

Story Posts.—Upright timbers used in sheds, workshops, etc., to support the floors, or superincumbent walls.

Stoup.—A basin for holy water in a niche in a Catholic Church.

Stretcher Course.—A course of masonry all stretchers and no headers.

Stretcher.—A brick or block of masonry laid lengthwise of a wall.

Striking a Centre, is the removal of the workwork after the completion of the arch.

String Board.—A board placed next to the well hole in wooden stairs, terminating the ends of the steps. The string piece is the piece of board put under the flying steps for a support, and forming as it were the support of the stair.

String Course.—A narrow moulding continued along the side of a building.

Struts.—*See Roof.* They are sometimes called braces.

Stylobate.—A plane surface raised either upon a certain number of steps, which were contained all round or upon a podium, which afforded no approach but in front.

Summer.—The large piece of timber placed over wide door and window openings; a lintel; a beam tenoned into a girder to sup-

port the ends of the joists on both sides of it. When it supports a wall it is called a bressummer.

Surbase.—The mouldings immediately above the base of a room.

Surmounted Arches, are those which are higher than a semicircle.

Systyle.—That kind of intercolumniation which has two diameters between columns.

Tabernacle.—The temporary edifice used by the Israelites for the performance of public worship until the erection of the temple of Jerusalem.

Table.—A flat surface generally rectangular, which projects from the naked wall, charged with an ornamental figure. A *Corbel table* is a horizontal ornament used for a cornice in Gothic buildings.

Tablets.—Projecting mouldings or strings are sometimes so termed, as well as shelves in libraries.

Tænia.—The fillet separating the Doric frieze from the architrave.

Tail-in.—To fasten anything by one of its ends into a wall.

Tail Trimmer.—A trimmer next to the wall, into which the ends of joists are fastened to avoid flues.

Tailing.—The part of a projecting brick or stone, etc., which is inserted in the wall.

Tambour.—The naked part of Corinthian or Composite capitals; the wall of a circular temple which is surrounded with columns.

Tapestry.—A kind of woven hangings of wool or silk, ornamented with figures, and used formerly to cover and adorn the walls of rooms. They were often of the most costly materials and beautifully embroidered.

Temple.—An edifice, destined in the earliest times for the public exercise of religious worship.

Templet or Template.—A mould used by masons for cutting or setting work; a short piece of timber sometimes laid under a girder.

Terra-Cotta.—Baked earth. Much used for bas-reliefs for adorning the friezes of temples. In modern times employed for architectural ornaments, statues, vases, etc.

Terrace Roofs.—Flat roofs.

Tetrastyle.—A portico consisting of four columns.

Throat.—A channel or groove made on the under side of a string course, coping, etc., to prevent water from running inwards towards the walls.

Tie.—A timber, rod, chain, etc., binding two bodies together, which have a tendency to separate or diverge from each other. The

tie-beam connects the bottom of a pair of principal rafters, and prevents them from bursting out the wall.

Tongue.—The part of a board left projecting to be inserted into a groove.

Tooth Ornament.—One of the peculiar marks of the early English period of Gothic architecture, generally inserted in the hollow mouldings of doorways, windows, etc.

Torso.—A mutilated statue of which nothing remains but the trunk. Columns with twisted shafts have also this term. Of this kind there are several varieties.

Torus.—A large semicircular moulding used in the bases of columns.

Tower.—A lofty building of several stones, round, square and polygonal, and which flanked the walks of a city. The tower of a church is that part which rises above the rest of the building and contains the bells.

Tracery.—*In Gothic Architecture.* The intersection in various forms of the mullions in the head of a window or screen.

Transept.—An open passage or way across the body of a church in the direction of north and south, either on the eastern or western side of the nave, or on both sides. These transepts are broader than what are called aisles, and there is generally an oratory or chantry at their extremity, sometimes denominated the north and south transepts.

Transom.—A beam across a double lighted window; if the window have no transom, it is named a clear-story window.

Tread.—The horizontal part of a step of a stair.

Trefoil.—*In Gothic Architecture.* An ornament consisting of three cusps in a circle.

Trellis.—Lattice work of metal or wood in screens or doors.

Triforium.—The space between the aisles of a church and the clerestory, often containing a staircase.

Triglyph.—An ornament on the Doric frieze, consisting of three square projections, or parallel nicks, and supposed to represent the ends of beams. They are placed immediately over the centre of a column in Roman Doric. In Greek examples the triglyph is surmounted by the mutule inclined, but in most modern profiles it is horizontal. On its soffit are represented guttæ or drops. The spaces between the triglyph or the frieze, are called metopes, and in modern examples, are made perfectly square and generally enriched with sculptures.

Trimins.—Pieces of timber framed at right angles to the joists for chimneys, and the well holes for stairs, when several joists are framed into one beam it is called a *trimmer* and the joists *trimming joists.*

Truncated.—Cut short.

Truncated roofs, are common roofs flat at the top.

Truss.—When the girders are very long, or the weight that the floors are destined to support is very considerable, they are *trussed*, so that the pressure is thrown more upon the walls.

Tuck-pointing.—Marking the joints of brickwork with a narrow parallel ridge of fine white putty.

Tudor Flower.—A trefoil ornament, much used in Tudor architecture.

Tudor Style.—The architecture which prevailed in England during the reign of the Tudors; its period is generally restricted to the end of the reign of Henry VIII.

Turkish Architecture, bears a great similarity to the Arabian style.

Turret.—A small tower, often crowning the angle of a wall.

Tuscan Order, is not found in any ancient buildings; the order admits of no ornaments, and the columns are never fluted.

Tympan of an Arch.—A triangular tube placed in its corners, usually hollowed, and sometimes ornamented with foliage, etc.

Tympanum.—The space inclosed by the inclined and horizontal sides of a pediment on the principal façade.

Under-pinning.—Bringing a wall up to the ground-sill.

Unity.—When an architect is charged with the construction of an edifice, he should first obtain a clear and definite idea of its nature and destination. By these means he will be enabled to invent and arrange the different parts, so that the *tout-ensemble* shall display unity. This cannot, perhaps, at all times be attained; in such a case it will depend chiefly on the taste and experience of the artist, to supply the deficiency, but at all events, whatever plan he may determine to adopt, that plan must be kept constantly in view, or the result, instead of being beautiful and harmonious, will turn out to be unsightly and incongruous.

University.—A collection of buildings for the education of youth.

Valley.—The internal angle of two sides of a roof.

Vane.—A plate of metal shaped like a banner fixed on the summit of a tower or steeple to show the direction of the wind.

Vase.—A name given to the bell, or naked form of the Corinthian capital, on which the leaves are disposed.

Vault.—Underground buildings with arched ceilings.

Venetian Blind.—*See blind.*

Venetian Door.—A door which is lighted on each side.

Venetian Window.—A window in three separate apertures

Vent.—The funnel of a chimney.

Vermiculated.—Stones, etc., worked so as to have the appearance of having been worked by worms.

Vestibule.—The place before the entrance to Roman houses; it was surrounded by a wall. In modern houses the small ante-room which leads from the outside to the principal hall.

Vestry.—A room adjoining a church, where the vestments of the minister are kept and parish meetings held.

Villa.—A country house for the retreat of the rich.

Vitruvian Scroll.—A name given to a peculiar ornament much used in classic architecture.

Volute.—A spiral scroll which forms the principal characteristic of the Ionic and Composite capitals.

Wainscot.—The wooden lining of walls generally in panels.

Wall Plates.—Pieces of timber which are placed as to form the support to the roof of a building.

Water Table.—A slight projection of the lower masonry or brickwork on the outside of a wall a few feet above the ground as a protection against rain.

Weather-Boarding.—Boards lapped over each other to prevent rain, etc., from passing through.

Withes.—The partition between two chimney flues in the same stack.

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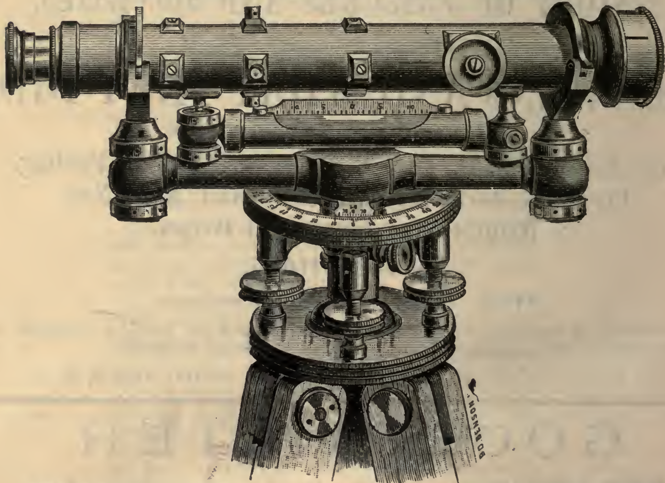

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